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ABSTRACT

Will the nation have the trained workforce required to deal with environmental problems in the 1980s and beyond? With the growing public concern about hazardous wastes, impure drinking water, polluted air, use and care of natural resources, and new legislation and funding targeted at these concerns, the need for examining workforce requirements and education and training capabilities becomes imperative, and was the subject of the conference reported in this book. The program focused on the following topics: (1) assessments of future job opportunities in occupations related to the environment; (2) available programs and curricula for occupational training in areas where growth in environmental opportunities is projected; (3) ability of the nation's schools, colleges, and other training facilities to meet anticipated needs; (4) guidance and counseling efforts needed to help students and workers assess their aptitudes and select appropriate training; (5) assessment of environmentally related jobs for minorities; (6) efforts to improve linkage between educators and industry, government, and labor to assure best use of education and training resources; (7) workforce planning for state environmental agencies; and (8) use of cooperative programs to meet state and local workforce shortages. Conference participants included nationally recognized planners, administrators, and policy makers in schools, colleges, industry, labor organizations, professional associations, citizen groups, and government agencies. Their 39 papers and perspectives comprise the chapters of this book. (KC)

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Determining Education and Training Requirements

(Proceedings of the National Conference on Meeting
Environmental Workforce Needs - February, 1981 -
Washington, D.C.)

Sponsored by: U.S. Environmental Protection Agency

In cooperation with: American Academy of Environmental Engineers; American Association of Community and Junior Colleges; American Association of State Colleges and Universities; National Association of State Universities and Land Grant Colleges; National Environmental Training Association; National Occupational Information Coordinating Committee; National Science Foundation; Sub-Committee on Environmental Education of the Federal Interagency Committee on Education; Tennessee Valley Authority; U.S. Department of Agriculture; U.S. Department of Commerce; U.S. Department of Energy and U.S. Department of Human Services, Bureau of Health Professions.

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Foreword

**Dennis A. Tirpak, Director
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Will the nation have the trained workforce required to deal with environmental problems in the 1980's and beyond?

With the growing public concerns about hazardous wastes, impure drinking water, polluted air, use and care of natural resources and new legislation and funding targeted at these concerns, the need for examining workforce requirements and education and training capabilities becomes imperative.

The National Conference on Meeting Environmental Workforce Needs in February 1981, focused on identification and assessment of training needs, reviewed education and training available and dissemination of findings.

Cooperating groups included: American Academy of Environmental Engineers, American Association of Community and Junior Colleges, American Association of State Colleges and Universities, National Association of State Universities and Land Grant Colleges, National Environmental Training Association, National Occupation Information Coordinating Committee, National Science Foundation, Sub-Committee on Environmental Education of the Federal Interagency Committee on Education, Tennessee Valley Authority, U.S. Department of Agriculture, U.S. Department of Commerce, U.S. Department of Energy and U.S. Department of Health and Human Services, Bureau of Health Professions.

The program focused on:

- Assessments of future job opportunities in occupations related to the environment.
- Available programs and curricula for occupational training in areas where growth in environmental opportunities is projected.

- Ability of the nation's schools, colleges and other training facilities to meet anticipated needs.
- Guidance and counseling efforts needed to help students and workers assess their aptitudes and select appropriate training.
- Assessment of environmentally-related jobs for minorities.
- Efforts to improve linkage between educators and industry, government and labor to assure best use of education and training resources.
- Workforce planning for state environmental agencies.
- Use of coop programs to meet state and local workforce shortages.

Conference participants included planners, administrators and policy makers in schools, colleges, industry, labor organizations, professional associations, citizen groups and government agencies.

Papers presented were from nationally recognized authorities in their respective fields. It is these papers which comprise the chapters of this publication.

Environmental Education and Training

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INTRODUCTION

In accepting the invitation to address the subject of "environmental training," the "Education" part of the title was added as representative of an observation I have made upon reviewing three decades of contact with environmentally related activities. To me, scientific notions, engineering analyses and designs, economic considerations, and public acceptance begin with education. Training provides the operational link between conceptual design and performance records.

This presentation is divided into five areas:

- a. a study of environmental manpower;
- b. rationale for environmental manpower planning and policy;
- c. educational competition at the professional level;
- d. specialized training; and
- e. summary.

I make no claim to originality for I have learned the significance of quality education and training from my teachers, professional engineers and scientists in the field, and master technicians. All of these have learned the art of problem analysis, design, and the management and operation of complex environmental systems.

My remarks are prefaced by a couple of comments; first, a concept of education/training, and second, to whom am I speaking?

A Study of Environmental Manpower

You would expect me to be interested in quality education and

training, but many others also have been concerned. In 1977 I had the privilege of chairing a Committee of the National Research Council (NRC), National Academy of Sciences (NAS) that produced a 427-page volume on *Manpower for Environmental Pollution Control*.¹ This study was directed by the U.S. Congress (House Report 93-275), Subcommittee on Agriculture, Environmental, and Consumer Protection of the House Committee on Appropriations. The NRC/NAS Committee was ably assisted by five panels.

In this study the Committee considered the profile of personnel requirements in the environmental area, estimates of personnel supply and demand, sources of personnel, the ways in which individuals with scientific and technical competence are brought into the pollution control work force, and the Environmental Protection Agency's (EPA) responsibility for education and training of manpower required for pollution abatement and control. The scope covered the range of manpower problems that EPA ought to be concerned with during the period 1976-1985.

This Committee assessed personnel needs stemming from emerging technologies and changing patterns of cooperation between federal, regional, state, and local governmental entities. The Committee explored the availability and use of training and education facilities and methodologies available for recruiting workers in manpower-short fields. The Committee evaluated the interaction between EPA and educational institutions, including exchange of scientific and technical personnel and funding of training programs to supply the expertise needed by state and local employers. Finally, the Committee reviewed EPA's use of scientific and technical personnel, especially at policy-making levels.

As a side note, although Congress authorized this study, I'm not aware of anyone on our Committee ever being asked by EPA to discuss this NRC/NAS report.

Also, The American Academy of Environmental Engineers prepared a report on "An Analysis of the Role of the U.S. Environmental Protection Agency in the Development of Manpower for Water Pollution Control".²

Rationale For Environmental Manpower Planning and Policy

It is logical to ask why should the EPA concern itself with environmental manpower? Many highly technological innovations have been accomplished without help from Washington. For example, traditional market mechanisms operated effectively to

allocate human resources with appropriate skills and in adequate numbers to successfully manage the highly innovative and technical endeavors associated with the computer and its related automatic data processing technology.

The NRC/NAS Committee found that there are four reasons for special concern with environmental manpower. These are:

- time schedules and specific goals that are imposed by environmental legislation;
- specific directions in environmental legislation which call for federal study of the appropriate labor markets and stimulation of manpower development in certain occupations;
- high levels and patterns of expenditures that are anticipated in achieving environmental goals; and
- the fact that environmental pollution control programs are highly reliant on the public sector.

This Committee concluded that a large-scale shortage of pollution control manpower was not apparent nor was a shortage likely to develop in the near future. However, shortages will occur in selected, specialized occupations. The true environmental manpower problem will not occur because there will not be adequate bodies available to hire; but a more serious problem will occur because the educational level of people available to work effectively just will not be up to the task.

Specific conclusions and recommendations covered in the Committee report included:

- a. priority of manpower policies;
- b. manpower planning;
- c. technical input to EPA decision making;
- d. assistance for state and local planning;
- e. use of advisory panels;
- f. research, training, and technical centers;
- g. environmental manpower requirements in the private sector; and
- h. continuity in operation of pollution control systems.

The Committee recommendations are as follows:

Recommendation 1

- "The Committee recommends that Congress clarify its intent for environmental manpower development and training activities in existing legislation and provide EPA with a clear directive concerning its manpower and training authority."
- "The importance of manpower needs should be recognized by Congress and the Executive Branch and appropriately reflected in the Agency's budget. Manpower planning and training should be

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adequately funded, and there should be no diversion of manpower planning funds to other activities."

- "To define and focus environmental manpower responsibilities in EPA, we recommend that a high-level group be established within its headquarters with representation from the regional offices to ensure adequate manpower planning and development. This group should coordinate and supplement the activities of manpower planning and training staffs in the program areas of air, water supply, wastewater, solid wastes, and other program elements."

Recommendation 2

- "The Committee recommends that EPA present to the Executive Branch and Congress a comprehensive program of support for the development of professional and subprofessional manpower and operators. This program should be appropriate to the legislated goals of controlling environmental pollution. Such a program should include a long-term strategy for environmental manpower development based on manpower planning and using the most appropriate educational techniques. The manpower program would be implemented at the federal, state, and local levels under the leadership of EPA."

- "An environmental manpower impact analysis should be made to assure that the professional and highly-trained subprofessional manpower required to implement environmental legislation can become available within the prescribed time. This thorough assessment of manpower requirements should be done when legislation is drafted and hearings are held, rather than after enactment of the legislation."

- "EPA should use these impact analyses as a basis for making recommendations to Congress and the Executive Branch concerning programs required to avoid shortages in the manpower necessary to carry out the proposed legislation."

Recommendation 3

- "EPA should better use its technical personnel to assure that its directives can be accomplished with existing or soon-to-be available technology."

Recommendation 4

- "The Committee recommends that EPA establish a well-coordinated federal manpower planning and training program for environmental control. Such a responsibility should be mandated by Congressional and Executive action."

Recommendation 5

- "The Committee, recognizing that delivery systems for specialized training are largely in the hands of state and local officials,

recommends that EPA pursue a three-part strategy to assist in monitoring and mobilizing these resources for pollution control:

(1) EPA should provide technical assistance and grants to give state and local agencies the tools needed to plan for manpower demands in environmental protection;

(2) EPA, state, and local environmental officials should work with education administrators concerning special training programs. Careful manpower planning is essential in order to make the most effective use of all available resources; and

(3) EPA should identify the gaps in state and local programs and prepare a national assessment of demand and supply. Working with the U.S. Department of Labor, the Office of Education, industry, and professional associations, EPA should provide leadership in the development of programs to support state and local manpower activities."

Recommendation 6

- "The Committee recommends that EPA increase its use of manpower analysis tools that are available both within and outside the Agency for a better understanding of future manpower requirements. Data sources and projection models from the National Science Foundation, Bureau of the Census, and Bureau of Labor Statistics should be used more extensively."

- "EPA should also strengthen its support for state and local manpower planning. Support should be encouraged from other governmental agencies interested in local labor market planning in order to develop an adequate data base. Emphasis should be placed on a detailed examination of portions of an overall manpower projection model, concentrating on more local or regional problems, or both. Efforts should be made to identify those occupational specialities that are critical to effective pollution control."

- "The Committee further recommends that EPA itself improve its environmental manpower projection methodologies by relying both on staff expertise and advisory committee evaluations. These projections should be disaggregated to specific job groups in each categorical program and to sufficiently small geographic areas to be of use to state and local environmental manpower planners. Much greater emphasis should be placed on accounting for those behavioral characteristics of the environmental labor force that are likely to have a bearing on imbalances between supply and demand, particularly at state and local levels."

Recommendation 7

- "The Committee recommends that a technical panel be established to advise EPA in manpower planning and education. This panel should include experts from state and local agencies, industry, and the academic community. Specifically, the panel should include engineers, scientists, manpower planning specialists, and managers of environmental control systems."

Recommendation 8

- "The Committee recommends that EPA make a major effort to develop local institutional arrangements to meet specialized training requirements. EPA should continue to develop training materials where appropriate, and to train instructors. Involvement in direct training should continue on a limited basis. Since participation is constrained when fees are imposed, the Committee recommends that EPA eliminate fees for these training programs."

Recommendation 9

- "The Committee recommends that, as a means for expediting technology transfer, personnel associated with technically-based environmental systems be provided with opportunities to obtain up-to-date career training by association with research activities. Funds should be allocated to educational institutions for development of environmental research and training centers that can serve as such sources for technical assistance to small businesses and to government. This recommendation should be accorded a priority high enough to assure student involvement in ongoing studies of pollution abatement and control methodology. Funding for such centers should be awarded on a competitive basis."

Recommendation 10

- "EPA should analyze manpower needs for industry and the private sector as these needs are influenced by existing and proposed environmental legislation."
- "EPA should obtain the participation of private industry in its training mission for environmental manpower. More specifically, student cooperative programs should be extended to potential employees, and continuing education efforts should be enhanced. Private industry should be encouraged to take a more active role in advising the appropriate educational institutions, environmental agencies, and EPA in their assessments of training requirements."
- "EPA should cooperate closely with the private sector to design and conduct a long-term personnel study to produce the data necessary to assess current personnel use and to project future manpower requirements and training needs."
- "Congress should appropriate funds to enable local agencies and organizations to provide technical assistance and accurate information to farmers and small businesses unable to afford technical manpower to carry out the objectives of environmental legislation."

Recommendation 11

- "EPA should recognize and study the critical necessity for continuous operation of biologically-based environmental protection systems and make appropriate recommendations to Congress concerning solutions to this problem."

Educational Competition at the Professional Level

Let there be no mistake about the fact that the flow of top-level graduate students into environmental programs has declined because the competition for undergraduate engineers by employers continues to withdraw some of the most talented from graduate studies. The professional leadership, research and the teaching pools are at a critical level.

The *Washington Post* commented:

"It is beginning to be seen in official Washington that the United States has absent-mindedly permitted decay to seep into the system for training some of the specialists who are indispensable to an ambitious, high-technology problem-laden society: engineers."³

To be sure, our trading partners are aware of the importance of technical education. The Royal Swedish Academy of Engineering Sciences in addressing the deteriorating economic growth conditions, a reduction from 5% to 2.4% during 1970 to 1975, recommended strengthening the knowledge base and stimulating the research base by 20% per year within five years.⁴

In Japan, 20% of all baccalaureate and about 40% of all master's degrees are granted to engineers, and these figures have been nearly stable for the past ten years. This compares with a figure of about 5% at each degree level in the U.S.

Congress reported in 1979 that Japan's productivity growth since World War II was four times the growth rate in the U.S. and 2.5 times better than the productivity increases in France, Germany and Italy.

There are problems on the horizon for graduate education. The 18 to 24-year old age group will decrease during the next 20 years. Declining Ph.D. production associated with the availability of more attractive opportunities in industry for persons with doctorates in engineering has resulted in 2,000 unfilled faculty positions in engineering schools. Everyone should know that the first academic programs that are trimmed when there is an economic crunch in academia are the highly specialized areas of study. Specialty courses and training in environmental engineering are prime examples.⁵

The shortage of engineers with earned Ph.D. or D.Sc. degrees is so critical that one report predicts the adequacy for this category to be problematic well into the 1990's even though the supply for engineering baccalaureates may approach the demand by 1990.⁶ Furthermore, the need for engineers and scientists holding graduate degrees to conceive, design and operate sophisticated pollution control facilities will increase dramatically.

To further complicate the problem, a large share of the graduate students in engineering have been foreign nationals. In 1977 about 43% of all Ph.D.'s awarded in engineering in the U.S. went to noncitizens. Of these, one-third to one-half ultimately returned to their own countries. During 1972 and 1977 the number of Ph.D.'s awarded to U.S. citizens in engineering decreased by 35%.

Specialized Training

Similarly, it should be obvious that no matter how much money and effort are expended, particularly in the public sector, to install facilities, it will be impossible to reach the desired goals without competent and responsible management and operation of the facilities. In contrast to University instruction for the professionals, performance-oriented training is recognized as an effective way to increase operator performance. Certification is valuable in assuring minimum qualifications. Certification examinations should stress the skills and practical training necessary to carry out the required operational assignments. More serious attention must be directed to the adequacy and quality of the required continuing education, i.e. short courses, for all levels of pollution control personnel. Also, there is a need for courses to be given by engineers and scientists for nonengineering students so that the latter have an understanding of the complexity of environmental problems.

SUMMARY

Let me review for a moment. What do we as a nation want in environmental education? Certainly the people expect regulatory consistency in education and training. And what could this nation provide if more attention were given to upgrading environmental education? We could halt the decline in numbers of qualified professionals and technicians. This educational mandate poses a bold challenge to those who write our laws and those who spell out the regulations. In simple terms, if the nation has better trained people there will be more cost effective environmental programs.

Fortunately, this nation is blessed with some of the best centers of excellence in environmental education in the world. It is imperative that this country look at greater support for these centers of educational excellence. Training centers are not as fully developed as the professional educational centers, but there are some exemplary models.

As I come to a close, I realize I've posed some challenging questions. The final one is, is it too late to do the job required? I

think not, but this country cannot expect much efficiency from a system that is increasingly being driven by designers, managers and technicians who have not had the quality of education and training that this nation can and should provide.

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Industry and Employment Projections for the Decade Ahead

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INTRODUCTION

The Bureau of Labor Statistics has a program for developing 5-10 year projections. This program encompasses projections developed on a 2 year cycle of: (1) labor force by age, sex, and race, (2) economic projections covering GNP and the income and expenditure components of GNP, (3) industry output and employment, and (4) occupations requirements in total and by industry. These projections are the framework used in preparing the Occupational Outlook Handbook. Currently, in the two-year cycle the labor force projections were published in December 1980. The economic projections are expected to be released late spring 1981, the industry projections are planned for early summer 1981 publication, the occupational projections in the late summer of 1981, and a new Occupational Outlook Handbook will be released in the spring of 1982.

I will draw upon the projections developed in this program for my remarks today. I will begin with a broad overview and as I narrow the perspective I will finish with comments on occupations dealing with the environment.

Labor Force Trends in the 1980's

The Bureau of Labor Statistics has developed three labor force growth scenarios; a high-growth projection, which assumes rapid growth in the labor force participation rates of

women in the 1980's and the convergence of participation rates between black men and white men under age 65; a middle-growth scenario, with the expansion coming from women; and a low-growth path with only moderate increases in the participation of women and with the divergence in male participation between races continuing.* For brevity I will only review the middle scenario for you today.

In the intermediate scenario, the labor force is projected to reach 115 million by 1985 and 128 million by 1995. This growth represents a rate of 1.8 percent per year from 1979 to 1985 and 1.0 percent per year rate from 1985 to 1995 (Table 1). Under this scenario, labor force rates of women age 20 to 44 are assumed to rise at an increasing rate until 1983. For most age groups of men, participation is projected to decline, although not as fast as they did in the 1970's. Overall, the participation rate is assumed to increase more rapidly for whites than for blacks.

Table 1: Annual rate of growth of the civilian labor force by sex, age, and race, 1975-79 and projected to 1995

Age, sex, and race		Projected			
		Actual 1975 to 1979	Middle Growth		
			1979 to 1985	1985 to 1990	1990 to 1995
Total, age 16 and over		2.67	1.86	1.25	.83
Men		1.70	1.11	.70	.52
16 to 24		3.15	-1.47	-2.17	-1.16
25 to 54		1.83	2.06	1.88	1.10
55 and over		-.91	.78	-1.20	-.57
Women		4.06	2.85	1.91	1.18
16 to 24		3.30	.49	-.50	-.21
25 to 54		4.88	4.28	3.24	1.73
55 and over		2.05	.45	-.61	.01
WHITE					
Total, age 16 and over		2.49	1.71	1.08	.63
Men		1.56	.96	.55	.36
Women		3.89	2.72	1.74	.96
BLACK AND OTHER					
Total, age 16 and over		3.97	2.97	2.39	2.02
Men		2.95	2.27	1.85	1.58
Women		5.15	3.71	2.92	2.44

* Howard N Fullerton Jr., "The 1995 Labor Force: a first look," Monthly Labor Review, December 1980, pp. 11-21.

Women provide most growth

More than two-thirds of the 1980-1995 labor force growth are projected to come from women. Women are expected to compose an additional 4 percent of the labor force in 1995. The increase in the proportion of employed women in the prime working-age group would more than offset the decreasing proportions of younger and older working women. In 1975, 46 percent of all women were in the labor force. By 1985, this is projected to increase to 56.4 percent under the middle-growth scenario. In 1975, women represented 46 percent of the labor force—by 1985 they would represent about 45 percent. On the other hand the proportion of men in the labor force is assumed to be slightly less. The activity rates of men age 25 and over is expected to drop. Rates for men and women under age 25 are

Table 2: Growth Rates for Selected Labor Force Groups.
Selected Periods Historical and Projected

	1965-79	1975-79	1979-85	1979-95
Youth	3.9	3.2	0.6	0.9
Prime	2.2	3.0	3.0	2.3
Older	0.4	.2	0.7	0.2
White	2.3	2.6	1.7	1.2
Black and other	2.8	4.0	3.0	2.5

moving up, but those for women are increasing faster. In the older age groups, where labor force participation rates for men and women are dropping, those for men are dropping faster. Hence, women's increasing share of the labor force reflects their own greater activity as well as the projected decrease in male labor force participation.

Until recently, labor force participation has been dropping for most age groups of black men, while their population has been increasing at a higher rate than that of whites. As the black population continues to grow at a faster rate, the black labor force also can be expected to grow at a faster rate. Thus, the black labor force is growing considerably faster—at about twice the rate of whites. Under the middle scenario, the racial gap in male participation rates is projected to approximately double from the percentage point difference in 1979.

With the aging of the baby-boom cohort, the numbers of those age 16 to 24 almost certainly will decline so that, despite a projected increase in their labor force participation rates, the

level of the youth labor force would fall. The prime-age workers (25 to 54 years), therefore, would be the fastest growing component of the labor force (Table 2).

Economic Trends in the 1980's

The economic projections being prepared by BLS include alternative projections of growth for the 1981-90 period. These alternative projections are intended to provide a range within which economic growth in this period will most likely occur. One projection is characterized by assumptions of continuing high inflation, low productivity growth, and moderate expansion in real production. Alternatively, the other projection assumes marked improvements in productivity, slower inflation rates, a higher labor force growth, and commensurately higher real production levels.

Demand

Gross national product between 1981 and 1985 in these two alternatives is projected to increase at an average annual rate between 2.8 and 4.5 percent. By comparison the 1955-79 rate of GNP growth, in real terms, was 3.3 percent. After 1985, GNP growth is projected to moderate somewhat primarily as a result of the projected slower labor force growth. GNP growth between 2.6 percent and 3.8 percent per year is projected over the last five years of the decade.

Personal consumption expenditures has steadily increased its share of GNP from 60 percent in 1955 to 64.4 percent in 1979. This trend is projected to come to an end in these projections because of the greater emphasis on capital creation. Within PCE the long term trend toward relatively more expenditures on durables and services compared to relatively fewer purchases of nondurable goods is projected to continue.

Investment

The demand for new housing has been expanding steadily throughout the post-World War II period, as the number of households increased by more than 30 million during the 1955-79 period. The increasing rate of household formation reflects both the baby-boom bulge and an increasing tendency toward single-person households. In both alternatives, real residential investment accounts for 4.3 percent of GNP in 1985. After 1985, residential growth is sharply slower in both alternatives.

In one alternative a rate of growth of 1.8 percent per year for business fixed investment is projected for the 1981-85 period. After 1985, consistent with assumptions about changes in corporate taxes, investment is projected at 4.3 percent per year. In the other alternative projection, different assumptions are made regarding the timing and changes in taxes affecting business investment, and as a result, investment in plant and equipment is expected to increase by 6.2 percent a year, 1981-85, accelerating further to a 7.3 percent annual real increase during 1985-90.

Government

The trend toward a smaller share of production accounted for by government purchases is expected throughout the 1980's. Federal defense purchases are projected to grow sharply in real terms during the early 1980's and then slow slightly after 1985. Nondefense purchases, on the other hand, are expected to decline in real terms between 1981 and 1985, and then to grow very slightly after 1985. In the state and local sector, the largest change from prior trends is expected to occur in the education sector. As the baby-boom cohorts age, a sharp slowdown in the growth of educational purchases is projected to 1985 with absolute declines after that year.

Employment and Hours

Over the projection period several major changes are expected to occur under the assumptions used. Total employment is expected to increase at an average rate of 2.0 percent each year between 1981 and 1985 in one version or an average annual increase of 2.2 million jobs. In the other alternative, total employment growth of 3.1 percent each year between 1981 and 1985 or an average increase of just under 3.4 million jobs each year is projected.

State and local government employment is expected to grow less rapidly than total employment. Enrollment growth has been moderating during the latter 1970's. The result is a very modest growth in the number of education-related employees during the 1981-85 period and slight declines during 1985-90. The declines, though, will be somewhat offset by continued growth in noneducational programs and the administrative employment associated with these programs, although at a less rapid rate than in the past.

As a result, private employment is expected to expand more rapidly than total employment over the entire projection

period. Thus, the trend toward relatively more government employees is expected to be reversed, at least until 1990 (Table 3).

Table 3
Employment Shares
Historical and Projected

	1955	1979	Alternative 1		Alternative 2	
			1985	1990	1985	1990
Total employment	100.0	100.0	100.0	100.0	100.0	100.0
Private	86.2	84.1	84.5	85.2	85.2	86.1
Farm	9.3	2.7	2.3	1.9	2.5	2.0
Nonfarm	76.8	81.4	82.2	83.2	82.8	84.1
Government	13.8	15.9	15.5	14.8	14.8	13.9
Federal	6.9	4.1	3.8	3.6	3.7	3.4
State & Local	6.9	11.8	11.6	11.2	11.1	10.5
Education	3.2	6.4	5.9	5.3	5.6	5.0
Noneducation	3.8	5.4	5.8	5.9	5.5	5.5

Industry Trends in the 1980's

Output

Agricultural output will continue to decline in importance through the next decade, reflecting relatively slow growth in food purchases in real terms. This slowdown will affect almost all of the food industries, and indirectly, the agricultural industries. Several other nondurable manufacturing industries over the projected period will also exhibit only moderate output growth, such as tobacco manufacturing, paper products, cleaning preparations, and leather products. One industry, refined petroleum products, will actually decline as demand for petroleum is projected to decline in the next decade as the impact of higher gasoline prices and more fuel efficient automobiles is felt. Although the nondurable goods manufacturing sector is projected to show only moderate growth overall, several nondurable industries such as chemical products, drugs, apparel, and printing and publishing industries, will post faster-than-average output growth. The durable goods portion of manufacturing will grow faster than the all-industries average resulting in a constant share of total private output accounted for by the manufacturing sector as a whole.

The services sector of the economy will continue its long-term trend of gradually increasing its share of total output. Primary among service sector growth will be the amusement and recreation industry and the medical industries.

The construction sector will grow faster than the all-industries average between 1981-85, but slower between 1985-90. In the first half of the decade, rising residential construction will stimulate this industry, but in the second half, a dropoff in new home construction will more than offset the beginnings of a rebound in business construction. Shrinking outlays for new construction of schools and roads by the government will also dampen the output growth of this sector.

Trade, which represented 19 percent of total output in the private economy in 1979, is projected to hold the same share in 1980. Within retail trade, eating and drinking establishments will grow faster than other retail businesses.

Output of the mining sector is forecast to halt its historical trend of decline as a share of the total private economy. This will occur primarily because the rapid increases in coal production will outweigh slow growth in domestic crude oil production and absolute declines in copper mining and nonferrous ores mining.

Employment

The distribution of employment among major industry sectors in both alternatives is projected to continue to change in line with many past trends. Leading the advance among service industries will be health care. Employment in doctors' and dentists' offices and in hospitals is forecast to grow faster than the all-industries average, but even more rapid growth will take place in other related medical care services like nursing homes, medical laboratories, therapists' offices, and nurses' services.

The trade sector is also expected to continue to rise as a share of all jobs, but within the trade sector the pattern of job growth varies. Wholesale trade will show only modest gains, while eating and drinking establishments in the retail portion are projected to have more rapid growth. The greatest number of new jobs created over the next 11 years will be in the trade sector, primarily because of its size.

Manufacturing jobs will grow slower than the rates projected for total jobs, but faster than manufacturing job growth in recent years. The turnaround in the rate of manufacturing job growth will be more pronounced for durable goods

manufacturing than for nondurables, reflecting the strong demand for consumer durables and for producers' durable equipment. Five of the 10 industries with the greatest rate of projected job loss are in nondurable goods. These five industries have already experienced job declines because of either falling demand or rapid productivity growth, and these trends are expected to continue (Table 4).

Although most major industry sectors are expected to follow past trends in terms of shares of total jobs, one exception is the state and local government sector. Employment in state and local governments has been rising as a share of total employment from 8.2 percent in 1959 to 12.0 percent in 1979, but by 1990, it is projected to account for 10.6–11.4 percent of all jobs.

The coal industry will be one of the fastest growing of all industries in the next decade because of the expected increase in the demand for coal. Over the past three decades, employment in the coal industry has experienced major cycles—declining 1950-65 and showing large increases in the 1970's.

Occupational Trends Expected in the 1980's

I will provide a brief review of the major occupational category of most interest to the group.

Professional and technical workers

This category includes many highly trained workers, such as scientists and engineers, medical practitioners, teachers, entertainers, pilots, and accountants. Between 1978 and 1990, employment in this group is expected to grow about 19 percent. Greater efforts in energy production, transportation, and environmental protection will contribute to a growing demand for scientists, engineers, and technicians. The demand for professional workers to further develop and utilize computer resources also is projected to grow sharply. Some occupations in this group will offer less favorable jobs prospects, in many cases because the supply of workers will exceed openings. Teachers will continue to face competition, as will artists and entertainers, airline pilots, and oceanographers.

Managers and administrators

Between 1978 and 1990, this occupational group is expected to grow 21 percent. The number of self-employed business managers will continue to decline as large corporations and chain operations increasingly dominate many areas of business.

**Table 4: Projected Industry Output and Employment
Changes Selected Industries, 1979-1980**

<i>Output</i>	<i>Employment</i>
Fastest growing industries: - Computers and peripheral equipment - Coal mining - Radio and television broadcasting - Iron mining - Transportation services - Optical instruments - Amusement and recreation services - Electronic components - Chemical mining - Construction, mining, and oilfield machinery - Office equipment - Material handling equipment - Telephone and telegraph apparatus	Fastest growing industries: - Other medical services - Typewriters and other office machines - Miscellaneous transportation equipment - Hospitals - Doctors' and dentists' offices - State and local transit - Other State and local enterprises - Automobile repair
Most rapidly declining industries: - Dairy and poultry producing - Alcoholic beverages - Leather tanning - Logging - Synthetic fibers - Other agricultural products - Railroad transportation and equipment - Wooden containers - Dairy products (processed) - Bakery products	Fastest growing industries: - Refined petroleum products - Copper mining - Private households - Nonferrous ores mining - Barber and beauty shops - Gas utilities - Tobacco manufacturing
	Largest absolute job gains: - Retail trade, except eating and drinking places - Eating and drinking places - Hospitals - Miscellaneous business services - Other medical services - Wholesale trade - New construction - Doctors' and dentists' offices - Banking - Educational services (private)

The demand for salaried managers will continue to grow as firms increasingly depend on trained management specialists, particularly in highly technical areas of operation.

Clerical workers

Between 1978 and 1990, employment in this large occupational group, is expected to grow 28 percent. New developments in computers, office machines, and dictating equipment will greatly affect employment in many occupations within this group. As computers are used more extensively to store information and perform billing, payroll, and other calculations, employment of file clerks and many types of office machine operators will level off or decline. At the same time, however, the need for computer and peripheral equipment operators will increase.

Sales workers

These workers are employed primarily by retail stores, manufacturing and wholesale firms, insurance companies, and real estate agencies. Employment of this group is expected to grow 27 percent. Much of this growth will be due to expansion in the retail trade industry, which employs nearly one-half of these workers.

Craft workers

Between 1978 and 1990, employment of this occupational group is expected to increase about 20 percent. Employment in nearly all construction trades is expected to grow, but particularly rapid increases are anticipated for heavy equipment operators, electricians, and plumbers and pipefitters. Among mechanics and repairers, employment will increase most among workers who repair automobiles, computers and office machines, appliances, and industrial machinery. In contrast, the long-run employment decline in the railroad industry will lessen the demand for some craft occupations concentrated in that industry, such as railroad and car shop repairers. Because of advances in printing technology, very little growth is anticipated in the printing crafts.

Operatives

Between 1978 and 1990, employment of operatives is expected to rise 15 percent. Employment of operatives is tied closely to the production of goods, because the majority of these workers are employed in manufacturing industries. The projected slow growth of some manufacturing industries along with improved production processes, will hold down the demand for many of these workers.

Service workers

These workers, most of whom are employed in service-producing industries, make up the fastest growing occupational group. Factors expected to increase the need for these workers are the rising demand for commercial cleaning services, protective services; and—as incomes rise—more frequent use of restaurants, beauty salons, and leisure services. Between 1978 and 1990, employment of service workers is expected to increase 35 percent.

*Trends for College Graduates**Demand for College Graduates*

The demand for workers with college-level training is affected by the growth of occupations that in the past have had a high percentage of college graduates. During the 1960's, professional and technical occupations were the fastest growing among all occupational groups because of rapid expansion in education and the high technology industries, which employed a great many teachers, engineers, and other highly skilled workers. During the 1970-78 period, however, the growth rate for these occupations declined. Over the 1978-90 period, growth in employment of professional and technical workers is projected to be even slower than it was during the 1970-78 period, because of the lack of growth in education and a slower growth in some high technology industries. In fact, employment in most other occupations is expected to grow faster than employment in professional occupations.

Higher proportions of graduates are projected to be needed in professional and technical, managerial and administrative, sales, and farm occupations, reflecting long-term trends in the increasing complexity of many of these jobs. The increased sophistication of management techniques, the greater amount of legislation affecting administrators, and the more advanced level of technology should all contribute to the upgrading of many jobs. Higher proportions of graduates are projected to be needed in service occupations, reflecting the upgrading of entry requirements in a few service jobs, such as police officers. The proportions of workers in clerical and blue-collar jobs requiring a college degree are projected to be somewhat lower in 1990 than actual 1978 proportions. Employers have not traditionally sought college graduates for these jobs, and, during the 1960's when other jobs for graduates were plentiful, few graduates entered these occupations (Table 5). During the

Table 5: Percent of workers in major occupational groups with 4 years of college or more, selected years, 1959-78 and projected 1990

Year	All occupa- tional groups	Profes- sional and technical workers	Manag- ers and adminis- trators	Sales workers	Clerical workers	Service workers	Craft workers	Opera- tives	Laborers	Farm workers
1959	10.0	56.1	13.1	10.1	4.9	1.4	2.1	0.8	0.5	1.4
1965	12.0	58.8	17.7	9.8	5.5	1.3	2.1	.8	.9	1.7
1970	12.8	59.8	20.1	11.8	4.7	1.3	1.8	.8	.7	1.2
1975	16.7	63.8	28.5	17.2	7.6	3.1	3.3	1.7	2.2	5.1
1977	17.7	65.0	31.4	19.1	8.4	3.7	3.9	1.8	2.8	6.3
1978	17.7	64.5	30.4	20.3	8.3	3.4	3.8	1.9	1.9	6.2
Projected 1990	19.0	69.3	40.9	24.6	6.5	4.0	3.1	1.5	1.4	9.7

1970's, however, the proportions of graduates in these jobs increased rapidly—reflecting, for the most part, the difficulty young people were having in filling more desirable jobs rather than upgrading of job content.

Supply of Graduates

Beginning about 1969, the job market for college graduates changed dramatically. Of the roughly 575,000 graduates who entered the labor force annually—on the average—between 1962 and 1969, about 73 percent entered professional and technical occupations. About 17 percent entered managerial and administrative occupations, another major occupational area generally felt by graduates to be appropriate to their education and abilities. Another 3 percent entered sales jobs. Less than 6 percent entered clerical, blue-collar, service, and farm occupations.

A different pattern emerged for the 1,150,000 college graduates who entered the labor force annually—on average—between 1969 and 1978. Although more graduates entered professional and technical occupations than during the previous period, the percentage finding these jobs was much smaller—only 46 percent—because many more graduates were competing for available positions. About 20 percent entered managerial jobs and another 8 percent entered sales jobs. It is estimated that about one-fourth of the graduates spilled over into occupations not previously sought or filled by college graduates. The great majority of graduates who took clerical, service, and blue-collar jobs over the 1969-78 period did not enter upgraded positions.

College graduates entering the labor force through the 1980's are likely to face job market conditions very similar to those faced by graduates during the 1970's as entrants continue to exceed openings in jobs traditionally sought by graduates. Estimates based primarily on National Center for Education Statistics projections of earned degrees indicate that about 13.5 million college graduates will enter the labor force over the 1978-90 period. In comparison, only about 10.2 million job openings are expected to arise in traditional jobs for college graduates. About half of these projected openings are expected to result from growth in the kinds of jobs filled by graduates in the past and from upgrading jobs, and half from the need to replace graduates, who retire, die, or leave the labor force for other reasons. About 1 graduate in 4 will probably

have to enter a nontraditional occupation. As in the past, college graduates will have an advantage over nongraduates, but in some fields they may have to compete with junior and community college graduates who have learned job-related skills.

Occupations Within Environmental Workforce

Most professional people in the environmental workforce have college-level training in a traditional scientific or engineering discipline. For many, this has been supplemented with on-the-job or advanced academic training in a specialized area applicable to the environmental field. Data on the employment of scientists and engineers in environmental work in 1978 are available from the National Science Foundation survey. About 100,000 scientists and engineers reported being engaged in environmental activities. Almost 70 percent of those reporting environmental/pollution control were engineers. About 13 percent were physical scientists and 12 percent were life scientists. The other 5 percent were environmental scientists (geologists, meteorologists, etc.), social scientists, mathematicians and computer specialists. About 11 percent of all scientists and engineers reported being engaged in these activities.

Outlook for Scientists and Engineers

BLS projects an overall rough balance between supply and demand for scientists and engineers through the 1980's. Overall, we anticipated a 20-25 percent growth in employment of scientists and engineers over this period. The employment growth cannot be disaggregated to show growth from environmental requirements—this is the pool from which most of the environmental workforce will be drawn. However, it seems unlikely that a 20-25 percent growth of environmental activities would create problems of availability of people with scientific and engineering background.

There is one very salient point in the supply picture, which makes the projection of an adequate supply of manpower seem plausible. The number of engineering degrees (including engineering technology) began to increase sharply beginning in 1978 (49,000 in 1977, 56,000 in 1978, 62,000 in 1979). Enrollments in engineering and scientific areas were at an all time high—indicating that degrees granted in the 1980's will be even higher. Enrollments are not likely to drop very much for several reasons. (1) A whole new pool of potential engineers—women and minorities—has opened up. They have accounted for much of the recent growth. (2) The long-term

oversupply of college graduates has also caused the shift to engineering, since engineering has not been affected by the oversupply. The Bureau projects this oversupply in other college level fields to continue through the 1980's, so that engineering is likely to remain attractive relative to most other fields.

That's looking at the broad picture. It doesn't mean that there won't be problems matching up the supply and demand for some very specialized scientific and engineering skills. From looking at the program, I presume other speakers will be addressing this question in detail.

Ocean Environment

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INTRODUCTION

A few days ago, I read a brief history of Washington, D.C. which may interest you. It seems that in its earliest days, a portion of Washington was a swampland with a rich assortment of snakes, mosquitos, flies and "an occasional wolf." The local Indians kept to their villages on drier, healthier grounds. A few hundred years later, as the city matured, that portion was — in the words of the history — "A raw, rowdy, bustling collection of shanties, brothels, and opium dens. . . ." What one finds on this property now includes the U.S. Department of Commerce. Incidentally, one of the villages from which the early Indians looked down upon this area was located on Capitol Hill.

Whatever you may think about these developments, it is important to note that there was change. And this leads me to the comments I would like to offer.

There should be little question that public awareness of the oceans has grown remarkably over the last 10 years. It matters little whether this was due to the price of fish, Costeau's TV films, the crowding of our beaches, the condition of Lake Erie, the Amoco Cadiz oil spill, news of the latest drilling efforts offshore for oil, or — for some — the tortuous path of the Law of the Sea and the potential impact of the treaty.

This awareness is linked with our country's increased dependence on the oceans over the last 10-20 years. One result has been the expression of this awareness and dependence through significant legislation that has been enacted in recent years. There is concern for adequate consideration of environmental values — such as with ocean dumping, clean water, and coastal zone management. And there is recognition of the ocean's resource values in laws such as those on extended fisheries jurisdiction to

200 miles offshore, deepwater ports, OCS oil and gas, ocean thermal energy conversion, and deep seabed hard minerals.

Future Ocean View Trends

The way we will be viewing the oceans in the future will be different than it is today. If the forecast is incomplete, at least the trend is evident — increasing use and development of the ocean's resources. Of importance, therefore, will be our ability to deal with competition and conflict in the ocean — critical resource extraction and impact on the environment, among resources — fisheries and oil, or some combination of resource development, the environment, and waste disposal.

The environmental work force needed in the future — by the developers and users, by environmentalists, and by all levels of government from local to Federal which must often decide among these in the overall national interest — should have an educational framework based on the most reasonable expectation of change in ocean use that can be predicted.

Some months ago, the National Advisory Committee on Oceans and Atmosphere — a committee established by law to advise the President and the Congress — initiated a project to develop selected national ocean goals and objectives for the next 10-20 years with a view toward providing a series of guideposts to advance safely an increasing use and development of the ocean and its resources. Our initial efforts include a picture of the future — how we will be using the oceans 10-20 years from now. It seems to us that there are a number of driving forces which will shape this use. There are no real surprises. It might be useful, nevertheless, for me to summarize a few of these for you as one framework for your continuing discussions later in the conference.

Among the driving forces we see are the Nation's energy needs, the need to develop our fisheries, and the growth of our population and its shifting concentration toward the coastal areas. These are the familiar ones. Also important are new — or perhaps non-traditional — uses and, scientific and technological developments — the pervasive impact of these on our use of the seas.

Much of the force for greater ocean activity derives from the social and economic needs of the Nation. These inevitably produce pressures for future use as well as pressures for protection from pollution. Some of these pressures will result from the emergence of the oceans as the preferred place to do those things which for some reason are or become unacceptable as land-based activities — for moving some of them off-shore

where undesirable impacts are minimized.

Here, then, taken from a forthcoming report of our Committee, is a description of these forces.

Ocean — Source for Energy

No issue will so dominate our uses of the ocean as will energy. Not only do the sea lanes bear the tankers that bring the oil we import and deliver the coal we export, but the seabeds are a major source of oil and gas; and the sea winds, waves, tides, salinity gradients, and temperature differences between ocean layers are all potential sources of energy.

Extraction and transport of energy resources interact with other uses of the ocean and the bordering coastal zone, raising issues of conflicting use. The use of coastal areas for energy facilities may conflict with maintenance of environmental quality and wildlife and fishery habitats; the development of offshore oil and gas fields raises questions of impact on sensitive fishing areas. The need to develop energy resources in harsh environments, such as the polar regions, raises special problems. Observations of the ocean environment are needed; pollution needs to be monitored; and impacts need to be understood.

Exploration and development of oil and gas resources on the outer continental shelf of the United States and on the continental shelves of other nations are accelerating. These activities will move into more hostile and remote locations and into deeper waters. Our polar seas around Alaska even now have become a focus for intensive exploration. The move to deeper waters in the Gulf of Mexico is under way. The Atlantic coast of the United States offers major potential for development.

In 1980, our continental shelves had nearly 6,000 wells producing oil and gas and over 300 drilling rigs installing new producing wells or exploring for new fields. These facilities, located in less benign seas, will be subject to new types of environmental hazards and conditions unknown in the Gulf of Mexico except for the sporadic impact of hurricanes. The technology to drill and produce in water depths to 1,800 meters has already been developed; and in the 1990's, drilling and production could take place at depths approaching 4,000 meters.

These activities will result in a demand for a specially trained workforce. Environmental information and forecasts will be essential for these remote areas where observations are now sparse. In developing these new frontier areas, new technologies will be used for deep-ocean drilling, for subsea completion of oil

wells, and for designs of platforms and other facilities to withstand the effects of sea ice on drilling structures and of operating at sea in subzero temperatures. The technology for transporting hydrocarbons from these regions to the refinery will evolve to include deep-ocean pipelines, pipelines in ice-scoured arctic areas, undersea storage of oil, and ice-breaking tankers.

Other Ocean Resources

Although the seabed oil and gas resources will be the dominant feature governing our uses of the sea for energy over the next two decades, there will be an increase in activities related to the exploration of the economic and technological feasibility of other ocean energy resources. The Ocean Thermal Energy Conversion Research, Development and Demonstration Act of 1980 and the Ocean Thermal Energy Conversion Act of 1980 include incentives that will likely result in large-scale demonstration plants in the next decade, and perhaps commercial plants by the end of the century. This legislation calls for production of 100 megawatts of power by 1986 and 10,000 megawatts by 1999.

Thermal energy development will confront the Nation with new requirements for information about oceanic and weather conditions. Lesser sources of renewable energy from the ocean, such as that available in the winds, waves, tides, and salinity gradients, also add new dimensions regarding the impact on and information needed for localized oceanic and atmospheric conditions.

Fisheries, historically and politically, have been major factors in the development of our seaboards. Fisheries have exerted a powerful influence on our needs and approaches to ocean management in the past, and they continue to do so.

The adoption by many nations of a 200-mile zone for fishery conservation purposes was an early offshoot of the LOS negotiations. In the U.S., the Magnuson Fishery Conservation and Management Act reserved for our fishing industry the single largest pool of living resources possessed by any country in the world when it extended our fishery jurisdiction out to 200 miles.

National policy appears to be heading in the direction of reducing foreign fishing as one step in the full national development of fish resources. The implications of this policy of fully developing these resources point to an increase in the size, diversity, and technical sophistication of the U.S. fishing fleets. It includes increasing the productivity of the industry, developing new markets for presently underutilized species, and expanding fisheries where the resources are not fully exploited.

The largest single change that NACOA expects to take place in the U.S. fishing industry will be the development of the capability to use the enormous resources along the Alaska shelf. The nature of the resources, the distance from shore-processing facilities, and the remoteness of the area seem to dictate that the U.S. fish capability will have to move towards larger vessels capable of taking and processing the fish catch inside the Alaskan waters.

Our fishery management systems will be more complex and will require more responsive environmental, ecological, and fishery catch and effort data. These data will be obtained in part through new observational techniques, such as space platforms which provide new kinds of environmental data, and manned undersea craft which seek information on spawning grounds and which can be used to study ecologically sensitive areas.

A marked growth of the U.S. fishing capacity off our coasts, a major development of the Alaskan fishery in the Bering Sea with implications for the composition of the fishing fleet, and new kinds of services to increase the productivity of our fishing industry, characterize this driving force.

Socioeconomic Factors

Population growth and the concentration of population on the coasts of the United States and its consequences are the major socioeconomic factors affecting the oceans in the 80's. Some estimates indicate that as much as 75 percent of the U.S. population will live within 50 miles of the coast and the Great Lakes by the end of the 1980's unless there are incentives or legislation which would arrest this transition. What people do, where they live, what they want, how, and when are clearly behind almost all demands for use of the oceans.

The nature of the demand may shift, as well as merely increase, with time. Crowding the coastal zone increases the vulnerability of life and property to violent storms and increases the problems of waste disposal, shoreline use and misuse, and makes environmental protection even more significant.

Out of this emerges potential for sharpening conflict, such as between waterfront development for ocean-related industrial or habitation use or preservation of open space, and balancing built-up areas with environmental consequences to the ocean.

The conflict in use can be met either by compromise or by

removing the source of the conflict. This is a problem for management, but management backed by facts, and by understanding of the consequences of human interactions with natural processes. Our future environmental work force will need the ability to cope with increased population density if we are to maintain a healthy environment.

As our coastlines become crowded, the ocean may have to be used for conducting certain activities, such as ocean power plants, cooling water, fish processing plants, offshore ports, offshore incineration, deep water storage of liquified natural gas, all of which, for one reason or another, become unacceptable as land-based activities. It is not unreasonable to forecast increasing effort in the future to move many of these activities to offshore incineration, deep water storage of liquefied natural gas. Here again, is a critical area for the future environmental work force which must understand and help determine the consequences of alternative courses of action.

Non-traditional Uses

Next, are new or non-traditional uses. The oceans have been used for a long time for what is there, for its fish, sand, gravel, shell, salt; in defense of our shores; for its open space; for its oil and gas; and in the not so distant future, for its nodules and other mineral resources.

NACOA believes that, increasingly, we will use ocean space for "housekeeping chores" previously barred from the sea by engineering difficulties or unfavorable economics. Technological advances are making possible several new ocean uses in response to our need to minimize the side effects of the products of industrial civilization without incurring increased environmental cost. The ocean can provide a place to process some noxious materials in a way which has the least effect on the total environment but takes advantage of the isolation of ocean space to minimize the impact on people. The environmental quality of the oceans of the future will depend largely on our ability to deal properly with waste management and to ensure that new uses of the ocean are assimilated with the least possible environmental stress.

Our growing needs on land are being matched by increased capability to do things at sea. For example, ocean thermal energy conversion (OTEC) which I mentioned earlier will provide floating plants able to generate usable energy from the ocean in the 1980's or 1990's. An OTEC plant could enable us to conduct energy-intensive manufacture in suitable areas at sea

where atmospheric or thermal pollution problems would be minimal.

Waste Disposal

Noxious waste disposal by incineration is another "new" ocean use. Lasting environmental damage can be avoided at the price of temporary local effects distant from heavily populated areas.

With respect to the ocean dumping of wastes, the Committee believes that there will be changes in our policies which will not eliminate the oceans as an option. The wastes of modern society that are not or cannot be recycled must be disposed of somewhere. If they cannot be disposed of on land or in the air, then they must be disposed of at sea or in space. The problem is to understand the impact of wastes on the various parts of our environment and select that method which is most suitable, least harmful, and least unpleasant and at a cost the country is willing to pay. It is in this context that the NACOA feels there will need to be a shift away from a no-risk attitude towards disposal of wastes at sea to an approach that will enable us to take advantage of the dispersive characteristics of the sea and its potential suitability for various kinds of wastes disposal in a way that will be protective of the environment.

Use of Science and Technology

Next, science and technology represent a different kind of driving force. Through science and technology, new possibilities open up and present ones made more productive.

The drive here comes from many sources. It comes from satellite platforms and remote sensing technology; from our enormously expanded ability to store and have access to vast pools of data and information in economical and responsive fashion. It comes from increased understanding of the geological structure of the seabed, which in turn leads to new frameworks for ocean resource exploration and development. It comes from the new understanding of the total ocean ecological system on which living resources depend and which set the framework for managing not only our fisheries but our coastal areas as well.

Satellites can be used directly to sense the characteristics of the ocean surface and the atmosphere above the ocean. Indirectly, they can be used to sense characteristics of the ocean depths by querying instruments in or on the sea. Satellites can transmit these data to satisfy operational needs for immediate information and to satisfy the longer term needs of research purposes.

We now have the ability to find out better than ever before what is happening over the vast bulk of the oceans. We can determine where storms are born and how they move, and where the fish might graze. Furthermore, we can obtain this knowledge at a cost that means improved productivity in what we do now.

In a different kind of example, we have had a fundamental change in our outlook for hydrocarbon resources in the seabed that has resulted and continues to result from our understanding of the geological origin of the structure of the sea floor. The Deep Sea Drilling Program of the National Science Foundation, which uses the drill ship, GLOMAR CHALLENGER, and the projected Ocean Margin Drilling Program, which will use the drill ship, GLOMAR EXPLORER, are basic science programs to explore and document the theory of plate tectonics and continental drift. The knowledge derived from this science will be increasingly useful in assessing the potential for oil and gas deposits.

Another example is the National Climate Program. Here one seeks to understand the basic physical mechanisms behind the variation of the Earth's climate. The role of the ocean is fundamental in producing the variations of the atmosphere for times greater than a few weeks. New observational techniques and technologies as well as new modeling capabilities will be required to address this problem adequately, with important implications for energy, fisheries, agriculture, transportation, and recreation.

Other Activities

There are, of course, other ocean activities of considerable importance such as marine transportation, marine recreation, and ocean mining of non-fuel minerals. Much of the impact of these activities are critical elements of the driving forces which I outlined earlier.

Marine transportation is an element of everything that needs to be done at sea. Marine recreation which now involves over 25 million citizens in boating and fishing is expected to increase substantially over the next decade adding to the pressures on our coastal areas. As for ocean minerals, a deepsea bed mining industry may well be in place in the 1990's. Perhaps sooner, sources of sand and gravel may be developed as land sources become economically or environmentally unattractive.

The foregoing has been a preview of some of our Committee's recent work.

I most note here that in outlining this ocean future, NACOA is not unmindful of the national economic situation and efforts by the President. Earlier I stated that the forces for greater ocean activity stem from our social and economic needs. The condition of our economy will certainly influence the pace at which the oceans assets are brought to bear on our needs. Nevertheless, there can be no question that the oceans do possess value for us. And our plans, such as for the environmental work force must include the long-term perspective for eventual safe and productive utilization.

SUMMARY

I want to wind these comments down by saying a little bit about the "practice" of environment. It does bear, perhaps tangentially, on the work force subject area.

An outsider looking at our basic laws must come away with a feeling of some despair that we have put ourselves into a box with no way out. We have laws on ocean dumping, on Clean Air, Safe Drinking Water, Clean Water, and one called Resource Conservation and Recovery. We control by medium — air, marine water, internal water, underground water, and land. One might ask, "what's left and where can I put the waste material being created by our modern industrial society and our increasing populations?"

Super efforts for ways to reduce waste products or to convert them to some useful purpose are certainly needed and should be a target for future training. Even so, I foresee nothing to eliminate the increased volumes of waste which must be dumped somewhere. Restrictions on ocean disposal create pressures on land and the atmosphere. These pressures, in-turn, could force a move toward the oceans as the preferred option since the wastes would be out of sight. And uncontrolled ocean dumping is clearly undesirable. On the other hand, neither are full bans on ocean dumping reasonable. The oceans do offer options for dumping when the nature of the waste and the nature of the geography are both considered and the environmental effects determined to be acceptable. We need that work force which can continually advance the information for judgments and those who can produce balanced judgments considering the total national interest.

So, there will probably never be an end to the competitive forces. And the pressures will vary — whether they be food,

energy, minerals, or the waste products of society. During difficult debate in the process of balancing activity and environment, it is easy to forget that both sides have white hats. Environmentalists are not as some characterize them — people trying to fool mother nature and keep the plates on which the continents move at their present location. And ocean users and resource developers are not trying to change the natural direction and speed of continental drift.

We need a trained environmental work force in all sectors to argue and resolve conflicts so that our rules are the best and most reasonable which can be devised to sustain a standard of living which we would like to have in an acceptable and affordable environment.

Equally important, we need a work force which understands that today's reasonable solution will — with good probability — be unreasonable some years downstream, not just because science, technology, and experience have taught us more about the environment, but also because there will be new economic, social and environmental pressures which will set a different frame of reference on the use of the oceans as a resource and a sink.

Shape of the 80's Food and Agriculture

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INTRODUCTION

The availability of food, fiber and fuel derived from agriculture is an issue of life and death significance, perhaps more properly an issue of war and peace. Nations go to war when food requirements are not met, resulting in biological, economic, moral and social chaos.

As the Reagan administration looks at this nation's strength to deter, prevent or win an armed conflict, it should recognize that our capacity to produce food, fiber and fuel is on the front line of preventing war and, if one should come, fundamental to winning it. We found that out in World War II. Around the world today, the United States' status depends greatly on the fact that over \$40 billion a year comes from agricultural exports.

Specific markets change rather quickly. The Iranian boycott of U.S. products and the partial suspension of trade with the Soviets during 1980 shifted and increased trade with most Latin American nations, Japan and Eastern Europe. Hot, dry weather caused Mexico to increase its import of U.S. grain as well. For the first time, in 1980 China became the top wheat buyer for the United States.

Yesterday's Agriculture

In 1940 a U.S. farmer could produce enough food to feed 11 people. Today the average American farmer provides enough food for 65 people—46 in the United States and 19 abroad. As impressive as this increased productivity is, it is nothing to what must happen in the immediate future. It has been estimated that over the next 30 years, enough food will have to be grown to equal all the food that has ever been grown until now. By the year 2000, the world population may reach 5 billion or more. To feed this population, annual food grain production must increase from the current 1.3 billion

metric tons to about 2.0 billion.

Let's take a different view. During the first 75 years of this century, *average* U.S. corn production tripled so that by 1975 we produced on the national average about 76 bushels to the acre. However, if world population growth remained at the same rate as it is now and we tried to produce corn in the same relative proportion, we in the United States would have to increase corn production by a whopping 170 bushels to the acre; an increase, mind you of 170 bushels to the acre by the year 2000.

If we were to achieve worldwide zero population growth in 50 years, we would still have to increase corn production by more than 120 bushels to the acre over the next three quarters of a century. If we achieved zero population growth worldwide in 25 years, by the year 2050 we still would have to more than double the rate of corn production to keep it in the same relative position that it is today. In other words, we would have to increase corn production by about 79 bushels to the acre.

Those are rather staggering figures considering the tremendous advances already made. The principal problem today is food distribution around the world. By the middle of the next century it will be the availability of enough food.

Tomorrow's Agriculture

Over the last half century, agricultural production has become a scientifically demanding occupation. Farmers and ranchers no longer can afford the time or uncertainty of making management decisions based solely on "guesstimates." Therefore, communications technology is being developed to help the agri-community make more efficient agricultural decisions.

The Kentucky Cooperative Extension Service, in cooperation with the USDA and the National Weather Service, has designed and tested a new home information delivery system, the "Green Thumb Box." One hundred Kentucky farmers in each of the two counties receive weather, market, agricultural production and home economics information via telephone lines from a microcomputer located in county agency offices. The Green Thumb Box receives, stores in its memory and displays information on the screen of a standard television set. From a computer "menu" of up to 999 agricultural subjects, the Green Thumb System provides information on research findings, insect reports and much more. Localizing information such as weather forecasts and frequently updating marketing, weather, soil, pest and chemical information, allow the farmer to translate information into action.

In Montana, Wyoming, the Dakotas and Nebraska, a related program called "AGNET" has been serving for five years as an

agricultural management tool. This program is based upon the belief that computer systems should be built to service the "noncomputer" persons' needs. Its program "menu" includes land purchasing models, simulation of grain-drying systems, irrigation scheduling, financial budgeting, economic analysis of feeder livestock performance, a general accounting and bookkeeping system and many more items. The AGNET system now includes not only the five states but users in 27 states. Banks, farm equipment manufacturers, feed companies and agricultural Extension Service offices take advantage of this simple system. Farmers and ranchers of the 1990s and the 21st century will use centralized computers to simulate management and marketing alternatives, giving them more time to do a business-like analysis of management options.

Other technologies are coming on line as well; one will allow a farmer to use a photoelectronic sensor to monitor the ripening of cornfields for computerized application of water and chemicals. Obstacles to implementing such technologies are principally economical, not technical.

While the number of U.S. farms has declined steadily since about 1935, the average acreage of a farm has continued to increase and will continue to increase. The number of farms with fewer than 100 acres is projected to drop by more than a half a million by the 21st century. Average acreage, however, is not the most useful measure of farm production because of the different kinds of farms and their geographic areas. For example, 1,000 acres might constitute an average wheat farm while 100 acres is a large fruit orchard. Similarly, a ranch on the U.S. Great Plains might be inefficient below 2,000 acres while a beef/cow operation in the southeastern United States might need only 250 acres. The relationship of farm size to geographical location occurs because most regions specialize in certain commodities.

Also, land is being taken out of agricultural use. A strip just east of the Rocky Mountains in Colorado is called the Front Range and includes Fort Collins, Denver, Colorado Springs and Pueblo. In the last two decades, this area has seen over 1.3 million acres go out of agricultural production.

Such statistics prompted the former U.S. Secretary of Agriculture to conduct 10 public meetings in which farmers and ranchers discussed the control of American agriculture's future.

American Farmers and environmentalists share a stake in a number of areas of which we might examine three: integrated pest management, energy and education.

Integrated Pest Management

The integrated management of pests combines the use of

chemicals, genetic principles and biological methods with farming techniques to achieve effective, economical pest suppression with a minimum adverse effect on non-target organisms and the environment. The idea has gained acceptance throughout the United States and other countries in recent years. It still recognizes that an ongoing war began millions of years ago between mankind and certain species of insects, weeds, pathogens, nematodes, rodents and other pests.

Since some pests have more resistance to a particular pesticide than others and with successive generations can inherit resistance to the pesticide, some imaginative approaches have been developed. In many species, insects of both sexes emit and respond to chemicals called pheromones which attract the opposite sex. Thus, by building a trap containing a pheromone attractant, the density of insects of a given species can be surveyed. This approach has been used in the fruit orchards of western Colorado, reducing the sprayings of peaches and apples from approximately 16 times per season to as few as two.

Another technique involves the breeding habits of a specific pest. For example, large numbers of screwworm flies can be sterilized artificially by radiation or chemical sterilants. Subsequently released into an area inhabited by wild populations, sterile males will mate with wild females. Since the female screwworm fly mates only once before laying her eggs, fewer screwworm offspring will be produced. By repeating this procedure for several consecutive generations, it is possible to eventually annihilate the wild population. This approach was used to eradicate the screwworm fly from Florida and the melon fly and Oriental fly from the small island of Rota, near Guam.

Presently, a research scientist at North Carolina State University is working to cross domestic tomatoes with wild ones native to South and Central America. The wild varieties are covered with glandular hair that secrete a sticky substance, trapping small insects that land on the plant. The pests are paralyzed or even fatally poisoned in a little as 20 minutes.

This built-in resistance can be relatively inexpensive, biomedically safe and compatible with other control methods the farm may use.

Another concern, however, is readily demonstrated with the grasshopper population on the U.S. Great Plains and the threat that this population has posed to crops of small grains. Spray programs and related efforts have brought the situation under partial control. One factor to be considered, however, is that if all grasshoppers were eradicated, the mite problem in corn could become oppressive because grasshoppers control mites. Thus, as one pest is controlled, relationship to other pests needs to be weighed carefully.

Energy

There are a number of major problems facing American agriculture including land and land use, water and water law, credit, federal constraints and the quality of life in rural communities. But perhaps the most important one on this list is energy. When discussing agricultural energy, two areas are significant; (1) the ability of U.S. agriculture to reduce its expenditure of and dependence upon petroleum based energy supplies and (2) U.S. agriculture's capacity to produce some of its own energy.

Energy technologies have been developed in several areas; wind-generated electrical energy; solar drying of crops and solar heating of agricultural buildings; methane production from both food and non-food and distressed crops; alcohol production from both food and non-food feedstocks; the direct combustion or pyrolysis of agricultural wastes; conservation techniques including low-tillage and no-tillage operations; biological control of pests and irrigation scheduling.

In Colorado, 13 percent of agriculture's annual cash outlay goes to purchase fuel. More than 27 percent is used to purchase fertilizers, herbicides, insecticides and related petroleum-based products. These percentages total more than 40 percent of the cash outlay per year, which means that energy costs will now be the principal driving force for food prices.

There are some new technologies on the horizon, too. Photovoltaics involves the direct conversion of solar energy to electrical energy. As a significant contributor to on-farm energy needs, photovoltaic technology is perhaps four or five years away, but it is coming and it is coming rapidly. Needed at the moment are demonstration farms on which all of these technologies, their inter-relationships with each other and with sound environmental practices can be demonstrated to the U.S. farmer and rancher. The rate at which these technologies will be adopted, allowing us to meet our future food, fiber and fuel producing requirements will be markedly influenced by reemploying on-farm demonstrations which have proved so successful in the past.

Academic Programs

Academic programs are another example of how agriculture is adjusting to meet its needs for the 21st century. A relatively new professional degree, the Master of Agriculture, is much more extensively used today to develop competencies in students, particularly in the areas of agricultural systems analysis and simulation, agricultural finance and total farm management. This type of program should be of particular interest to environmentalists because of its emphasis on minimizing chemical

use and controlling the waste runoff from feedlots and other agricultural enterprises. What we in agriculture are rapidly beginning to realize is that what once were considered waste products should be viewed as renewable resources, for example, using fecal waste from feedlots and distressed crops as feedstocks for methane production. We recognize that it is economically and environmentally important to reduce herbicide, insecticide and fertilizer use in food production systems. We are no longer able to wastefully use nitrogen and phosphorus fertilizers or biologically non-degradable spray chemicals. Academic programs in agriculture even are emerging at the level of Doctor of Agriculture. Emphasis in all of these advanced programs is on interdisciplinary efforts and the integration of knowledge. In fact, I think you will find such people to be excellent candidates to fill key environmental manpower slots.

At the time of the Revolutionary War, over 95 percent of our population made its living on or from the soil; today, over 95 percent of our population depends upon a modern American minority, the farmer and rancher, to produce food and fiber and soon to produce fuel. Perhaps it's time for the academic community to initiate the agriculture appreciation courses analogous to the art and music appreciation courses that emerged post World War II.

Maybe it is time for agencies and people with environmental interests to become aware of agricultural problems from production to processing to distribution and retailing so that agriculturists and environmentalists can become partners in increasing our country's productivity and strengthening its future.

Chemical Perspectives

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INTRODUCTION

In thinking about what I might say in discussing chemicals in the environment, it comes to me that Alvin Toffler in his book, *Future Shock*, describes the scenario there, going to a different point but one in which I find a number of parallels as regards to chemical industry, the development of chemicals, our manufacture and our use of chemicals. The point ultimately that comes to me is a sense of urgency. The needs are just around the corner—just in the year 2000/2050. And in similar fashion, the exponential growth of the manufacture and use of chemicals rises to a sense of urgency. And where is that sense of urgency going to be addressed but through the Environmental Work Force Development Program, especially as it relates to the programs devised and put forth by the academic community.

Thinking about chemicals, it occurred to me that we've taken an awful long time to get where we are, but now that we've gotten here, we're going like blazes. We're really moving out. Mankind's progress up to this point has taken thousands of years. We've gone through our ice ages, our Stone Age, our Bronze Age, the Iron Age and during this time, the natural experience with chemicals has been very limited. After all, you have minerals and you have certain plants that give rise to a rude school of medicine, a rude practice of smelting. But chemistry itself has been characterized in that vein with the picture in your mind of the alchemist; the alchemist sitting with his conical hat on and his tripods, little brazier. What is he after? He's trying to figure out how to turn lead into gold. I have a feeling that he's not going to get there real soon.

As the population grew and the population density of areas grew, we started running into public health problems. And as a community we addressed those problems and we solved them. Public health in that context was the subject of bacterial health hazards. We handled problems relating to the sanitary needs of the population living as a community: cholera, diphtheria, malaria. And these were the subjects of public health. But these are not the subjects of public health in the next decade, I perceive, at least not those in the forefront. Rather, we're dealing with the subject of public health in the context of chemicals now. These chemicals, in a sense, are alien to our environment. These organic molecules, these complex products of man's ingenuity, are difficult to break. Their effects may take generations to develop, and the field of public health of the next decade then, is going to relate more and more to the subject of chemicals.

We have entered this chemical age since the turn of the century passing through an age of technology. But the age that's upon us is the age of chemicals—the age of science. With this age we have the picture now of large plants and small plants—production facilities, producing chemicals. Now, many of these chemicals we're not aware of because we never see them. These chemicals are, of course, the industrial intermediates. They are the solvents, the dyes, the monomers, which never reach the population in a marketing context directly. But many do and we are becoming increasingly aware of them. In prior discussions the increase in farm productivity was treated. This is through pesticides and fertilizers. And these are chemicals. These are not just chemicals; these are, in many cases, amazingly complex and toxic chemicals. In our household products, you would be surprised, I think, at what is in such ordinary things as cosmetics and cleaning products. For instance, we're all familiar with the ubiquity of plastics. They're all around us. But let me tell you something about plastics that perhaps you didn't know. Plastics usage will grow, not decrease, as the energy crunch increases. As a packaging material, plastics are less energy intensive than many of the more common packaging materials that have been in use up to this point including glass, aluminum and steel. Our textiles have seen an amazing transition in the past 50 years from natural fibers to synthetic fibers. And the end is not in sight. Such ordinary things as the paint that we put on our houses have gone from whitewash to latex paints, all sorts of exotic finishes and even now to space age finishes. Probably the two areas that impact us directly has been in our foods and

our medicines, where the chemical age comes truly into its own. These manufacturing facilities not only produce these chemicals—these products, these intermediates of design, they also produce byproducts, waste products and product contaminants. They even produce off-spec products. These chemicals, then, are entering our environment not only directly but also indirectly. We tend to think of environment almost from the third person. It's a subject of the birds and bunnies of the ecologists, of the people with the long hair and the bib coveralls and that sort of thing. But that's not true anymore. We must think of the environment as a personal thing because the entrance of chemicals into the environment is a personal thing. The things that we use, that we handle, and that we wear are of chemical origin. The food that we eat is increasingly modified with chemicals. The water that we drink is often modified with chemicals, sometimes to our benefit, sometimes not. Even the air that we breathe is becoming increasingly modified with chemicals. So the point of all this then is that the pace of development of chemical production and use has been explosive. And the pace of development of environmental science and technology has not been. We have failed, we have skimmed the cream off the top, as it were, of the environmental data bank. The hard part is ahead, both in terms of the intellectual effort and in terms of the cost to the nation with respect to the benefits that we seek. It's my perception that there are huge gaps in our data base. And furthermore, there are huge gaps in our understanding of the interrelationships that we seek to adjudge in making our decisions in the future. What are the alternatives that we have? What are the risks associated? What are the benefits associated? And it's going to have to be done in a mode that allows a rational decision because the effects of those decisions are going to be too far-reaching to be based upon vague environmentalism or vague conservatism or whatever you want to identify as the "ism" of choice. I think that these gaps in our data base, these gaps in our understanding of the interrelationships that we all have to know about, define part of the needs of the Environmental Work Force Development Programs in the next 10 years. So what needs to be done? What are some of these gaps and where are some of the areas that we can identify academic interest, national interest and need? Let me give you some examples.

Data Gaps

We've already said that the chemicals in the environment are hard to treat and that the effects of these chemicals in the

environment may take generations to develop. The fact of the matter is that we are barely able to describe those effects, either ecologically or in terms of the effect on human health with any degree of specificity. Some of the problems in this area of intellectual endeavor are obvious. It's difficult to get volunteers to test for health effects of chemicals and properly so. But nonetheless, we've got to establish the linkage between our laboratory work and our ability to translate into the effects on people if we're ever going to make decisions relating to the environmental tradeoffs that we have to make.

Another area where our data is inadequate at this stage is in the area of transport and fate of pollutants, especially the organic chemicals through the environment. One of the subjects of current interest is the subject of groundwater. Much of our drinking water comes from the groundwaters of the United States yet we're barely able to actually predict, to trace the flow to predict or to identify, the route of movement through the groundwaters of organic chemical contaminants with any degree of specificity. We've found this out in Love Canal. EPA spent something like \$6 million trying to identify the groundwater paths of the contaminants from the Love Canal with some success.

Technology Needs

As a chemical engineer that formerly worked in industry, I stand back and study the technology options available to us today on an economical basis and I'm aghast. Look at it this way: To clean up the water, we have biological treatment, something like a hundred years in development and there it is, the same biological treatment that began a hundred years ago is still the water treatment technology of choice today. I think that's astonishing.

With regard to air pollution control, about the best we can do now is talk about scrubbers. Technologically, scrubbers are not the most exotic thing that I've ever heard of. With respect to hazardous waste, we seem to have no viable option except to bury it. And we can't even agree upon how to insure that burial site against leaching and intrusion into our groundwater supply. And so there are needs in technology. We need advanced technology; we need resource recovery technology. We're going to have to learn to look at these pollutants as misplaced resources in fact and not just pay lip service to it. This technology is going to have to be cheaper and more efficient. And if this technology can't compete economically, it's not going to succeed.

New Scientists and Engineers

So the job is cut out for the scientists and engineers of the next decade. I think that the future for chemicals in the '80s is going to give emphasis to these educational and training needs. The scenario in my mind is more chemicals and more concern. We can predict population increases, increased manufacture and use of chemicals (I've already described the diversion of energy petroleum to plastics as a for instance), and we can see diminished water supply in many parts of our nation. It is only logical therefore to expect that the population at large is going to exhibit more and more concern with the management of chemicals in our lives and in our environment as time goes forward. But the subjects that I've identified as curriculum areas that I think could stand emphasis are not all that we should look to. I think that there's a new area—several new areas of need for the future that aren't taught. And these are the subjects that deal with the integration of our knowledge. What we really need is a lot of specialists who are generalists. We've got to have an authoritative integration of some of the diversity of subjects that are now currently taught. Let me give you some examples of what I think are these new fields of study. We're talking about the decision-making modes in the next 10 years as they regard the environment and especially as it regards these alien things called chemicals in the environment. We've already seen some shifting of curricula—from, for instance, civil sanitary to the thing now called environmental engineer. I think we'll see more. The description of what happens if we don't do environmental controls or if we don't learn to live with our chemicals is an area where very little has been done. We're entering an age where the cost of everything that we do is going to be much, much higher, and the ostensible benefits are going to be much more difficult to define. These are going to lead us into the area of intermedia tradeoffs.

Cost/Risk Benefits

Intermedia tradeoffs for example is in the field of water pollution control, we have historically gone blindly about our business treating the water, and the water that's discharged is nice and clean stuff, but you ought to see the sludge pile. The associated costs, and the environmental effects associated with the generation of that sludge pile are now becoming more and more subject to concern. The cost of cleaning up one media, then, at the expense of not cleaning up, or of polluting

another media, in the context of cost benefit or risk benefit, is going to be the kind of subject in the future that we're going to have to have the intellectual capacity to deal with if we're going to make rational decisions such as on the subject of ocean disposal.

When we go beyond simple cost benefit, you get into the subject of risk assessment. This area involves the biologists, the transport and fate people, the technology people and the public health people. And in the end, you've gotten together a committee, and everybody knows what committees are about. It's very difficult to get a handle on the subject called risk assessment. This is another area of integrative science. In the next 10 years, it is going to be necessary to develop an ability to make rational decisions as they regard our care and feeding of the environment particularly with regard to the manufacture and use of chemicals in our modern society.

SUMMARY

I have given you my perception that our manufacture and use of chemicals is pervasive. There's a sense of urgency needed to address the subject of chemicals in the environment. The educational and training needs associated with dealing with these chemicals in the environment in the next 10 years is a matter of great concern. It's going to be the subject of whether or not we're able to cope with this chemical age in which we live. There are integrative needs; I'm not sure how we get there from here, but I can clearly see the kind of person that has to be there. It's this person, who knows a lot about a lot of things and is able to bring them together in a focus that makes sense. The environmental work force needs that we're looking at, are the people who will be the leaders and the authors of the rationale of the very basic bedrock approach to decision making regarding chemicals, their cost, benefits, their blessings and their problems in the 1980's.

Perspective On Training Needs

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INTRODUCTION

EPA's National Training and Operational Technology Center (NTOTC), located in Cincinnati, Ohio, serves as the focal point for the Agency's water pollution control education and training program. NTOTC conducts a variety of activities to support and assist in meeting the training needs of a broad range of individuals involved in water pollution control programs. Major activities include the following:

Planning, Development, and Evaluation

Although no broad, comprehensive needs surveys are currently conducted, NTOTC does recognize the need for these, especially with the changes occurring in agency priorities. NTOTC currently uses less formal means of assessing training needs, including a direct survey of EPA Regional and Headquarters program managers; contacts with organizations, individuals, and institutions involved with training; course demand; informational requests; and reviews of EPA program decisions and legislation.

Training Delivery

A variety of training courses are presented or sponsored by NTOTC at the EPA facilities in Cincinnati, at recently established Area Training Centers, or at other locations around the country. Most courses are presented primarily for the

benefit of EPA, other Federal, State, and local agency personnel. Courses address a variety of technical and program implementation topics.

Support

A number of educational and training institutions and organizations are involved in designing and delivering training and training-related activities throughout the country. NTOTC provides a broad range of services to assist these institutions and organizations. Services include advising on the design and implementation of training programs and courses, developing packaged training materials and courses, and providing limited financial support for the development, piloting, and demonstration of new programs.

Communication/Coordination

Through its Instructional Resources Center (IRC) program, NTOTC facilitates the establishment of more efficient and effective education and training programs. The IRC enables trainers and educators to find and disseminate instructional materials, and to exchange ideas and information. The heart of the IRC is the Instructional Resources Information System (IRIS), a computer-based retrieval system that includes abstract information on over 3,000 print and non-print materials related to education and training in the water quality field. Other activities include workshops, a newsletter, monograph series, and a lending library of audio-visual materials. In the past few months, groundwork has been laid for the piloting of an IRC-based microcomputer network for the dissemination of training materials.

Because of its broad, national involvement in a variety of water quality education and training activities, NTOTC has a unique perspective on training needs. This paper will review the size and nature of the water quality workforce, assess related training needs, and identify some areas of concern and emphasis for future education and training programs.

Needs Assessment as the Basis for Planning

Planning is the initial step which should precede any program development. Planning for training should include the assessment of needs related to pollution control personnel performance, assessment of needs related to implementation of regulations, the identification of resources already existing that can meet those needs, the determination of needed

resources not currently available, the development of implementation plans, and finally, the evaluation of the effectiveness of those plans.

Detailed needs assessments or workforce analyses in the water pollution control area have not been conducted by EPA in the past few years. Several reports and papers published in the mid-1970's provided basic survey information and projections for the workforce in the water pollution control area. The declining emphasis on workforce development and training by EPA in the last 5 years eliminated support for additional efforts to continue these or more detailed studies. However, information from available reports does indicate the nature of the water pollution control workforce and the potential training needed to insure the effective use of that workforce. At NTOTC, we supplement this information by our own internal mechanisms for determining priorities for training activities. This includes an analysis of program directions and priorities established by Federal legislation or Agency policy decisions.

Workforce Study Results

A number of studies have investigated various aspects of the water pollution control workforce. These studies have examined most of the major occupational and employment categories, including treatment plant operations, state and local regulatory and control agencies, consulting engineering firms, and pollution control equipment manufacturers. Although these surveys do not cover all personnel who are involved in programs to control water pollution, they do address a large percentage of employment categories.

Treatment Plant Operations

Treatment plant operations constitutes the largest single employment category in the water pollution control field. In 1974, several estimates put the total municipal wastewater treatment employment (professional, operator/technician, and unskilled) at about 45,000. The estimate for employment in the total wastewater system, including wastewater collection, was 85,000. An EPA internal study of the same year put the wastewater treatment facility workforce at 67,000, and estimated that the staff needed to operate plants to meet the 1977 secondary treatment goal of the Clean Water Act was 85,000.

A 1977 study by Middlebrooks, et al., included estimates of 1974 municipal treatment plant personnel which ranged from

approximately 61,000 to 67,000.¹ This study also indicated that 76,000 employees would be needed to obtain secondary treatment levels of existing wastewater plants.

A more recent study, completed as part of the EPA draft *1990 Strategy* for the construction grants program, estimates that by 1990, 138,000 senior operators/superintendents, operators, and other employees would be needed to staff plants.² This projects a 30 percent employment growth rate in the next decade. This need for skilled water pollution control personnel is further compounded, however, by an extremely high turnover rate, which may be as high as 34 percent, according to Middlebrooks.¹

The studies cited above indicate a wide range of employment estimates, a fact not unexpected in the broad and diverse area of municipal wastewater treatment facility operation. Based on this information, however, the current workforce in municipal facilities is probably in the range of 80,000 to 100,000 employees.

State Agencies

The Middlebrooks study developed estimates of current and projected employment for State regulatory agencies.¹ Because of expanding water pollution control programs, State agency employment was expected to double from approximately 6,000 in 1974 to 12,000 in 1985.

Some additional staffing has taken place in the 29 states that have signed agreements with EPA to assume varying levels of authority to administer the wastewater treatment facility construction grants program. Under the 1977 Amendments to the Clean Water Act, states are allowed to use two percent, to a maximum of \$400,000, of their grant allocation to cover costs of managing the program. The result of this delegation has been to increase the level of State agency employment in the construction grant program from less than 1100 in 1977 to more than 1400 at the current time. Continued increases to achieve full delegation employment levels should result in a total State program level of more than 2200.

Federal Agencies

Although EPA is the largest single Federal agency employer of personnel in the water pollution control field, many other agencies employ professionals, technicians, and support personnel to carry out a variety of water pollution control activities. These include treatment plant operations, water quality surveillance and analysis, research, and planning and im-

plementing a variety of pollution control programs. Although Federal workforce survey information is not available for just the area of water pollution control, it is estimated, based on the information contained in the National Academy of Sciences report, that at least 15,000 Federal employees work in this area.

Industry and Private Sector Employment

Information on employment in the industrial and private sector is less comprehensive and complete than in other areas of water pollution control activities. The 1972 study by Middlebrooks estimated that 1972 employment levels by consulting firms for individuals working in the water pollution control area were about 15,000 engineers and scientists and 12,000 technicians.³ Based upon significant anticipated increases in Federal aid at the time of the study, employment by consulting firms was expected to increase significantly, up to twice 1972 levels.

Middlebrooks also investigated levels of employment in the planning, design, and manufacturing of water pollution control equipment and found 6,000 engineers and scientists and 18,000 technicians employed in this industry in 1974.⁴

Private industry also operates wastewater treatment plants to control water pollution from a variety of industrial sources. The NAS report estimated employment at these facilities to be approximately 11,000 in 1974.

Summary

Based upon the above references, the author believes that the following represents a very conservative estimate of current employment in the water pollution control field.

Municipal wastewater treatment	
facility operations	80,000
State agencies	10,000
Federal agencies	15,000
Industry and Private Sector	115,000
Total	220,000

This review does not include some areas of known activity, such as research and development, where survey information is either nonexistent or sketchy at best. Undoubtedly, there are also other places where individuals are employed in activities related to water pollution control. The vast majority, however, are included in the estimates cited above.

Throughout all of the studies cited, an attempt is made to delineate the occupational categories involved. A wide variety of disciplines are involved in the planning, development, implementation, and monitoring of water pollution abatement programs, including engineering, biological and physical science, planning, administration, law, and operations.

Training Needs

The need for training in the water pollution control field continues to grow, stimulated by the implementation of legislatively mandated programs. Coupled with this growth in magnitude are training needs generated by changes in pollution abatement technology and program requirements and procedures. Although it is difficult to be specific about training needs of all water pollution control employment sectors, we can indicate some future trends of needed programs based on our knowledge of the workforce and existing pollution control programs.

The development of any training or educational program should be preceded by a good needs analysis to support the design and implementation of effective training activities. We must reiterate that a good needs analysis is particularly important because of continuing changes in current programs and activities. Training programs provided by an institution or organization must be responsive to the "information, knowledge, or skill gap" that exists between what an individual already knows or can do and what that individual needs to know or be able to do to accomplish a given task.

Examples of rapidly changing areas with training implications include toxic and hazardous substances, laboratory analytical procedures, wastewater treatment technology, and water quality assessment and control planning.

Many of the specific training needs relate to the employment categories discussed previously: treatment facility operations, state and federal agencies, and the private sector.

Treatment Facility Operations

Reports by Hegg, et al., and Gray, et al., support the conclusion that immediate training needs exist in the areas of process control and treatment system management.^{7,8} Many operators do not thoroughly understand the wastewater treatment process or have difficulty applying process control knowledge to in-plant conditions. These are some of the major reasons given for the fact that estimates show approximately

50 percent of the wastewater treatment plants currently in operation are not in compliance with their NPDES permits. A more recent GAO survey of 242 treatment facilities showed 87 percent of them in violation of their effluent discharge limits, 31 percent seriously.⁹

Similar training needs are indicated for operational consultants, treatment plant designers, and instructors of operator training programs. All must have their technical knowledge and other capabilities kept up-to-date. In-plant operator training programs must also be established or improved because the plant site can probably be one of the most effective training facilities.

Training needs are emerging in the area of pretreatment for industrial effluents and hazardous wastes. Knowledge of analytical procedures to detect such wastes, as well as pretreatment and in-plant treatment technology, is needed. Effluent monitoring procedures, particularly where there are health implications such as use for water supply, recreation, or groundwater recharge, is another area of need. The growing interest in the application of wastewater and sludges to land indicates another area of needed training, particularly in the analysis of sludges for heavy metals. Training in procedures to conserve energy in treatment plant operations is also urgently needed.

Although operator training receives much attention in State agencies, educational institutions, and professional organizations, the level of support has generally been inadequate to provide enough of the training needed to address the operational problems of present treatment facilities. Future training efforts should be based on State-wide coordinated training programs. Joint State training coordinating committees are encouraged to improve the effectiveness of individuals and organizations involved in operator training, especially through the use of State 109(b) or other State training centers.

State and Federal Agencies

The delegation of the construction grants program to the States is generating a significant training need for State agencies. Training courses for State agency to address the procedural requirements of the grants program. Technology courses, particularly in the areas of facility design and operation, will be increasingly necessary as State staffs are enlarged.

Professional and technical staff personnel in State and

Federal agencies will also need much of the same training in the treatment facility operations area discussed above. In addition, training is needed in the area of enforcement, water quality monitoring, and determination of waste load allocations.

Industry and Private Sector

Most of the training needs identified in the area of treatment facility operations also apply in the private sector. Because of the growing awareness of continuing noncompliance of treatment facilities with permit requirements, it is expected that operational consultants will be more involved in solving plant performance problems. To achieve success in this endeavor, expanded and improved private sector capability will depend on effective training efforts. There also is a significant need for training of design engineers to improve the operability of treatment facilities through better designs.

There also is a need for continuing training of design engineers in areas of new treatment technology, particularly for small treatment systems, innovative and alternative technologies, and energy efficient designs.

Public Education

Although not part of the workforce under discussion here, improved education of the public is essential to achieving and maintaining water quality goals. Public participation is an essential part of an effective decision making process. Education and training is needed in the areas of the basics of water pollution and waste treatment technology, understanding the basics of risk assessment, and understanding the public decision making process.

We also need a stronger educational effort to shape the general public's understanding of water quality problems, the seriousness of those problems, and the interactions with other environmental quality problems. We need to impact public attitudes toward pollution abatement efforts, and develop a broader public contribution of pollutants at the source.

CONCLUSIONS

It is exceedingly important to recognize that we cannot depend upon technology alone to clean up and control our water pollution problems. A qualified, well-trained workforce in adequate numbers is essential to success. People are needed to

determine the problems; to find suitable, acceptable, and economical solutions; to design and construct abatement and control facilities; to operate those facilities efficiently, effectively and safely; to monitor the results; and to enforce against violators.

Water pollution control is a "people-oriented" business. The need for education and training of those people is growing and changing, and the need is only partially met by existing education and training organizations. At the present time, EPA support of education and training activities is and probably will continue to be limited. Increased support is needed for State and educational institution programs. It is essential that all employers of personnel in the water quality field recognize the need for well-trained employees, and provide the support to acquire that training.

Better coordination of all of our education and training efforts is needed to improve their effectiveness, through the sharing of program concepts, ideas, and curriculum materials, and elimination of duplication of effort in program design and implementation and materials development. At the operator training level, the development of State and National joint training coordinating committees is a step in the right direction, but similar efforts are needed on a broader scale. Existing organizations, such as the National Environmental Training Association (NETA), the National Association for Environmental Education (NAEE), and the Association of Environmental Engineering Professors (AEEP), could provide a mechanism to achieve such coordination. NTOTC's Instructional Resource Center (IRC) program can also be a useful tool for improving coordination.

And finally, there is a need for greater involvement of institutions of higher learning in short course training. Curricula for both short courses and degree programs should be examined carefully and redesigned to emphasize practical applications, current technology, and current pollution abatement programs and policies. This may result in more specialized programs in both environmental engineering and environmental science to respond to a broadening spectrum of water quality issues and problems.

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*** An AAEE Perspective on Manpower Needs for Water Pollution Control**

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INTRODUCTION

The American Academy of Environmental Engineers has analyzed the question of what should be EPA's proper role in the development of manpower skilled in water quality control. The Academy has concluded that the federal role should be a major one, and that *the present EPA policy of leaving manpower development primarily to marketplace forces is inappropriate and fails to respond to a growing national need. Its reasons for adopting this policy are unpersuasive. EPA should take the leadership role in assuring an adequate and appropriately trained environmental workforce. Financial support is an important part of this leadership responsibility.*

The environmental protection field is explosive in terms of the range and complexity of the proliferating problems it must address. There is nothing esoteric about these problems — they are immediate, pressing, and ubiquitous — from chemical contaminants such as halogenated hydrocarbons in water supplies, to acid rain, which complicates the nation's energy planning and its international relationship with Canada.

Environmental problems evolve constantly, but their evolution appears to be discontinuous — they arise unpredictably.

*Summary Chapter of AAEE Report entitled: "An Analysis of the Role of the U.S. Environmental Protection Agency in the Development of Manpower for Water Pollution Control."

Who, three years ago, could have effectively anticipated such environmental threats as Love Canal and Kentucky's Valley of Drums? Though undoubtedly there were some individuals who sensed such threats, nothing was done to forestall their development into crises situations. Like many other environmental problems — including the kepone contamination of the James River, the PCB contamination of the Hudson River, and the possible fluorocarbon threat to the ozone layer — the hazardous waste crisis sprang full-grown into the public consciousness, to the accompaniment of public fear and scientific uncertainty.

Such environmental problems hit hard for a number of reasons, a major one being that we lack skilled manpower to effectively anticipate them and to expand our often scanty knowledge of how to deal with them. A highly skilled workforce, adequate in numbers and prepared to communicate effectively with workers in the allied sciences, must be the heart of the environmental protection effort. A complication in this respect is reluctance of private consultants to guarantee the design of remedial works, since the risk of failure could be high. EPA should seek to employ the best skills available in such cases, while relieving the consultant of financial and legal responsibility he would normally assume.

There is a lack of skilled manpower for many important tasks. This is evident in our slowness to assess the relative importance — whether great or small — of new problems and to devise responses that are appropriate. A first logical step would be to define quantitatively what constitutes an adequate manpower base for the many specific tasks essential to comprehensive water quality management. These range from routine technician-level functions at wastewater treatment plants to the policy setting and decision making functions of federal and state planners. *Our national manpower requirements are yet to be projected in terms of specific numbers for each major task category and in production rates of trained workers to meet our skilled manpower needs.*

Estimates of need are feasible for at least certain categories of personnel, for example, wastewater treatment plant operators and technicians. Such estimates may be extended to categories of manpower required by state water pollution control and water supply agencies. These estimates should be made when possible, and they may best be made by the EPA.

We recognize the substantial uncertainty which now exists

in projections of many other worker categories. This is particularly true for specialized manpower required when unexpected problems are recognized, or new unanticipated responsibilities are placed on federal and state regulatory agencies. *This uncertainty is unfortunate; it is a major justification for the development of special training programs that will prepare such workers to undertake new tasks, or to move in new directions.*

Strain on manpower supply is evident in both new and established federal programs. The new hazardous material clean-up program that must be developed if the proposed "super fund" legislation is enacted will make heavy demands on appropriately trained personnel. EPA estimates that approximately 3000 man-years of effort involving a wide variety of skills will be required by this program during the foreseeable future. But the well-established wastewater treatment facility construction grants program is also suffering from a shortage of skilled manpower. EPA has established that more than half of the facilities constructed under the program fail to perform up to design specifications. The nonperformance is attributed partly to faulty design (probably due to insufficient trained personnel in the design firms) but mostly to improper operations and maintenance. These are fundamentally manpower education problems.

The problem of manpower goes beyond the need for personnel adequately trained to operate and maintain treatment facilities, critical as this need is. The problem extends to preparation of personnel adequate in number and training to monitor our drinking water and waterways, devise appropriate treatment schemes, and do the kind of planning that is necessary to relate these efforts to specific local, regional, and national needs. It includes, too, the very special preparation required by those on whom the public depends for solutions to the emergencies of today and the new problems of the future. *AAEE, whose function is to assure a high level of competence among those who make their careers in pollution control, is concerned over the inadequacy of current EPA support for development of this critical manpower.*

The Environmental Protection Agency should support environmental training. This is a suitable and appropriate role for the federal government to play, and one for which ample precedent exists. In its 1975 report, the Federal Interagency Commission on Education (FICE) noted that federal involvement in areas such as research and development is so dominant that

government decisions have a far-reaching impact on both supply and demand for knowledge and manpower. The question is not "whether or not", said FICE, but rather "how much" and "in what areas" support is necessary. Environmental training is a prime candidate for support. *The federal government has an important stake in the production of an adequate supply of skilled environmental manpower; it also has a legislatively mandated role in this area.*

Under pressure from the Office of Management and Budget, EPA severely cut back its support of training of professional manpower during the middle and late 1970's. The agency has reduced its staff for all kinds of training by approximately half during the last several years. In 1976, and in every year since then, it has attempted to eliminate completely its support of graduate level training. Only intervention by Congress has kept this program alive.

EPA bases its policy of eliminating support for graduate pollution control training on the belief that "the free market is now ready to take over", that is, that market forces will tend to assure an adequate supply of properly trained environmental manpower to meet the country's needs. This view is incorrect. For a number of reasons, the marketplace cannot effectively handle environmental manpower development.

Environmental manpower supply is not just a numbers problem; the quality of the workforce, and its composition, are fully as important as its size. *Market forces alone cannot address the quality side of the problem.* Marketplace forces do tend to provide that, if a given number of positions are open, then approximately that number of positions will be filled, but such forces cannot assure that they will be filled either appropriately or effectively. In its 1977 study on pollution control manpower, the National Academy of Sciences observed that the supply of environmental engineers has been significantly augmented by crossovers from other fields. Such intermixing may have some benefits, but there is little reason to believe that its net effect will be beneficial in a field as technically demanding as pollution control. Crossovers rarely have had the training necessary to be true environmental engineers and are, therefore, often poorly equipped to interpret complex instructions or assess decision impacts.

The suddenness with which new environmental problems often arise points up another danger of depending on the marketplace to produce the needed force of engineers, scientists, and technicians. *Market forces operate too slowly and too*

unresponsively to supply personnel capable of dealing effectively with rapidly evolving problems. Environmental protection, more than many fields, is an area in which "an ounce of prevention is worth a pound of cure". Market forces cannot effectively supply manpower to serve this "preventative" function. The results are too few qualified persons assigned to highly important tasks, a delayed response, and a poorly protected public. In its 1975 report on federal support of graduate education, FICE presented as one of the basic principles for such support this concept: that in situations where market response would be slow and the social cost of such a slow adjustment is high, then federal stimulation of a response to changing manpower and knowledge needs would be justifiable. Development of an environmental workforce for protection of public health and welfare presents such a situation.

A further weakness in the marketplace argument is related to the fact that less than half of those working in the environmental field are employed by private enterprise. In order for the free market concept to be applicable, salary levels and numbers of positions must be readily changeable to respond to changing market conditions. However, about 43% of the environmental workforce is employed by government and almost another 10% by educational institutions, where this kind of rapid response simply does not occur. *The environmental marketplace is thus a distorted one, and cannot be expected to function even as effectively as a true free market.*

It is also relevant in this connection to point out that the 1975 FICE report indicated that in cases where federal employment involves a high percentage of personnel in a particular area, *it is cheaper for the government to finance their training at universities than to train them itself or to wait for market forces to supply them.*

Far from assuring an adequate supply of appropriately trained environmental manpower, *marketplace conditions are actually damaging to at least one aspect of the field — they discourage B.S.-level engineers with exceptional promise for advanced study from entering graduate school for specialized environmental training.* According to the Scientific Manpower Commission, the average starting salary for an engineer with a B.S.C.E. in 1978-79 was \$1,402 per month. The starting salaries of graduates from M.S.C.E. programs (often the degree earned by environmental engineering specialists) is not substantially higher than this, only \$1,595 per month. Thus, there is not a major economic incentive at present for an engineer to go beyond the bachelor degree level.

Without financial support, such as EPA formerly supplied, graduate school becomes even less inviting. All technical fields need a percentage of highly trained specialists to provide direction and long-term research capability, including the preparation of highly skilled research workers. This need is particularly acute in the technically challenging, constantly changing environmental field. Market conditions that discourage graduate training may well prove damaging in the long term.

The drawbacks inherent in relying on the marketplace to supply the necessary number and mix of environmental personnel are exacerbated by the fact that, while environmental problems are widely recognized, the fields of environmental science, engineering, and technology are not generally familiar to the public. *The environmental fields suffer in competition with the better-known technical and scientific specialties.* Graduate stipends and training support are therefore especially useful as recruiting tools for environmental education programs.

Thus, there are major reasons why it is not reasonable to expect market forces to effectively replace federal support of environmental training. *The contention that the marketplace alone cannot do the job is, in fact, borne out by the recent shrinking of graduate training programs for environmental specialists.*

Environmental problems have proliferated during the years since EPA decided to phase out its graduate training support program. Nevertheless, the output of graduates from the schools has been markedly reduced during this period. From a high of about 2400 in 1972, the number of master's level graduates with environmental engineering specialties plummeted to 1000 per year by the middle of the decade. The number of new M.S.-level students in wastewater engineering fell from 1200 in 1972 to only 400 in 1976, a distressing 68% decrease. There has since been some tentative and partial recovery and the number of graduates in 1978 (the most recent year for which data are available) reached about 1400 — still little more than half the level of the early 1970's. Demonstrably, the private sector *has not* taken over training costs, and there is little reason to expect that it will do so in the future. Many schools are finding that, because of the relatively small size of environmental departments and the very specialized nature of the training that must be provided, they simply cannot afford to offer strong, balanced environmental training programs without federal support.

A weakened training base for professional manpower in

pollution control impairs our ability to protect the nation's natural resources and the public welfare. This function is inherently part of the role of government. Private enterprise regards environment primarily as a raw material and commonly finds environmental protection measures to be a restraint on normal business. The push for environmental protection has been public, not private; and the driving force for reform has been federal legislation. This dichotomy between the interests of government and those of private enterprise is a fundamental reason why responsibility for environmental protection functions cannot be shifted from the public to the private sector, and why the government has a special responsibility to assure an adequate supply of properly trained environmental manpower.

Where there is a shortage of adequately trained environmental personnel, the pinch is felt most strongly in the public sector, particularly at the state and local levels, because careers at these levels of public service are generally less rewarding financially than those in the private sector, and therefore less attractive. Government, therefore, has a very direct stake in the manpower question.

Furthermore, it is the public agencies that are in the front line when new environmental threats arise, and that require flexible, quickly adjustable programs to provide skilled professional workers in times of stress. It is also the governmental agencies that must decide on the technical feasibility of pollution control methods proposed by potential polluters. Such agency decisions often call for large expenditures which may affect the economy of the areas involved.

EPA not only makes important decisions affecting the expenditure of private funds on pollution control, it is also a big spender in its own right. More than \$20 billion has been appropriated for the agency's construction grants program. Skilled, well-trained personnel are the key to reducing capital costs for treatment facilities, through design innovations, and to controlling soaring operation and maintenance costs, which are a source of growing concern. It is fully reasonable for EPA to spend some public funds on training in the interest of restraining overall public expenditures, and in protecting the investments of the taxpayers.

An additional federal priority is affected by the environmental manpower training program. Many studies have shown that the impact of environmental degradation is greatest on people from minority and low-income groups. Career opportunities in environmental health can help fill the needs of such

people to work in a field relevant to public health. Since students from such groups tend to have less of the financial resources necessary to become qualified in this field, their only hope is through the mechanism of federally supported training programs. Without such programs, members of minority and disadvantaged groups have essentially no opportunity to become qualified for work on environmental health related projects.

If the federal government elects to reduce or eliminate environmental manpower training, the states are unlikely to take up the slack. Funding for training programs is usually considered to be "soft money" in state budgets, and is one of the first items to be cut. Furthermore, trained environmental personnel move freely from local and state jobs to federal agencies or other states so there is no assurance that a state would benefit from money spent on training personnel. However, trained environmental personnel are a national resource and help to achieve the goals of federal legislation wherever they work, be it in a federal or state regulatory agency, a local treatment system, a facilities design office, or elsewhere in an environmental job.

Federal support of training is an EPA legislative mandate. Congress provided authority for a wide variety of training activities in the environmental statutes it has enacted. The Clean Water Act contains provisions for professional graduate training, research fellowships, direct training, technician training, curriculum development, operator and instructor training, and workforce forecasting. Similarly, the Clean Air Act includes provisions for professional graduate training, graduate fellowships, consortia support, special programs, short-term technical training, and work force forecasting. Federal solid waste legislation also authorizes expenditures for training and education.

Clearly, federal support of training activities is part of the plan envisioned by Congress. *While it was never intended that EPA be the sole support of environmental education, it is clearly the responsibility of the agency to identify specifically the specialized manpower requirements for the implementation of its legislative mandates, and to provide the educational support, particularly financial, necessary to assure that these human resources are available.*

A federal share of responsibility applies to a wide variety of personnel needed in the water quality/environmental field, including:

- a. technicians who operate the treatment facilities, who

need a high school education plus a certain level of technical training;

- b. professional engineers who analyze environmental problems and develop solutions and who supervise, and regulate pollution control facilities, who need a minimum of a bachelor of science degree plus graduate education to the master's degree level; and
- c. highly educated scientists and engineers who normally need a doctorate to develop basic knowledge, plan and direct the graduate educational programs, and do supporting research.

The federal interest applies also to a *range of educational programs needed to train this variety of personnel*, including:

- a. undergraduate and graduate educational programs to provide a relatively large number of well educated personnel on a year-to-year basis through associate, bachelor and master's degree programs
- b. graduate level university programs to provide a relatively smaller number of doctoral level people to plan and direct the academic and research programs;
- c. continuing education (short course) programs to provide updating for large numbers of environmental personnel at all levels already working in the field; such courses should be widely available; and
- d. special university-centered crises training programs to address environmental emergencies.

It must be recognized that traditional education and training methods alone cannot supply the needed skills and that continuing education programs are of key importance. All levels of training should be oriented to current and future problems and ways of dealing with them, rather than to the perpetuation of past practice. As part of this effort, the methods of providing continuing education must also be evaluated and improved. The development of novel, highly effective means of knowledge transfer for all practitioners, at all levels and in all specialties, merits high priority. EPA's recently initiated programs toward this end justify optimism.

There is also a need for a further very specialized kind of training program, which might be called crises training. These programs, probably university-centered, should have the ability to marshal money, people, and resources to rapidly develop the methodologies for dealing with true environmental crisis situations as they arise. The Love Canal situation provides an example in which such a flexible and high-powered program could be helpful. Successful handling of incidents such as the

one at Love Canal requires the development of knowledge and skills in a spectrum of specialties, including transport of hazardous materials within the ground, diffusion of these materials into water supplies, fate of the substances *in situ*, diffusion of volatiles, specific measuring methodologies, and specialized clean-up techniques.

Crisis training centers could rapidly mobilize the available basic knowledge that must be brought to bear to resolve environmental crises. Such programs could meet the immediate demand for trained personnel, and also concurrently develop curricula relevant to the particular problem area, which could then be incorporated into training materials for all levels of environmental education, all the way down to the two-year technologist level. However, no university could or is likely to undertake such activities without financial support.

The question of skilled manpower shortage cannot be answered simply in terms of how many positions with the word "environmental" tacked onto their titles are filled. *The critical question is: Are the right number of people with the right kind of training available?* This is not an easy question to answer. Since environmental staffing is more than a numbers problem, the supply may appear to be adequate when, in fact, it is not.

Environmental manpower surveys have repeatedly predicted shortages. The most extensive survey to date, the National Academy of Sciences report on Manpower for Environmental Pollution Control (1977) concluded that there will be no overall shortage, but predicted spot shortages in specialized areas. It recommended (page 383):

"To assure that there will be available professional, technical and operational personnel needed . . . it is recommended that the Federal government encourage and financially support substantially increased academic and other personnel training programs without further delay."

In response to a congressional request, EPA prepared in May 1979 a report on what the agency felt its proper role should be in assuring adequate environmental manpower through graduate training support. *The EPA report relegates direct support of graduate training to the lowest priority of any training activity considered by the agency. The reasons given for this low ranking are not persuasive.*

The key factors affecting EPA's position on graduate training support are, according to the report: (1) concern over causing an "overkill" effect similar to the post-Sputnik push for scientists and engineers in the 1960's; (2) a policy of encouraging state self-sufficiency in environmental programs; and (3)

the lack of state and regional data on which critical shortages exist. None of these "key factors" stands up very well under scrutiny.

The agency's concern regarding overkill would be reasonable if there were any observable signs that an oversupply of environmental specialists was developing or had ever existed. There has been no such sign. On the contrary, all major environmental manpower surveys to date, including the voluminous NAS report, have predicted at least spot shortages of personnel. A 1977 report prepared for EPA and NAS projected that an additional 8000 engineers would be required by just the public sector by 1985 in the wastewater area alone. The EPA report itself claims no more than that "at present, there is little objective information to show whether or not the supply of graduates is adequate in comparison with demand." How then, did fear of creating a surplus come to be a key factor in discouraging the funding of graduate training? There is no evidence to support such concern.

EPA's policy of encouraging state self-sufficiency in environmental programs is sound and very much in keeping with the will of Congress, but it has little to do with graduate training support. States can approach manpower sufficiency through state-supported training in such areas as assumption of permit program and construction grant program responsibilities. But states do not have the history of broad training support appropriate to the federal government, and they are unlikely to develop such traditions. EPA acknowledges in its 1979 report that its effort to encourage workforce planning at the state level and to encourage the use of in-state university systems to meet professional training needs "has met with little success."

The final "key factor" cited in the report — lack of data on where shortages exist — is difficult to understand. Lack of data is a poor basis for a policy decision and in itself reflects insufficient EPA attention to an important responsibility.

The monies necessary to permit EPA to assure that adequate, properly trained manpower is available to realize the nation's environmental goals are not of a magnitude to have a significant impact on the agency's overall budget. It may rather be that, because they are so small in comparison with many other budgetary items, they are viewed as incapable of accomplishing anything of significance. Actually, just the opposite is true. *The few million needed for manpower training represent a sound investment that will produce an excellent return to the taxpayer. It would have a major impact on the*

worth of the billions of dollars spent on facilities construction and other efforts to control pollution now and in the future. To neglect training in the name of savings is to risk much to save little.

The Environmental Protection Agency should re-think its position on support of manpower training. In the words of the National Academy of Sciences report, "It is not realistic to assume that training of needed environmental manpower will occur without incentive and financial support instigated by the federal government. . . . EPA especially, should assume leadership for the responsibility in providing the supply of required manpower." The American Academy of Environmental Engineers endorses this recommendation and offers to EPA its assistance in the complex task of developing realistic assumptions and appropriate strategies for meeting this responsibility.

It is recommended that a monitoring function be performed under the auspices of the Environmental Protection Agency. This does not necessarily need to be a unit within government but could be operated under EPA funding in the setting of a university or commercial organization. This "human resources monitoring unit" would have two main functions: early warning and reporting of acute problems. The early warning activity should be closely tied to the monitoring apparatus already in place. That apparatus is predominantly in the hands of other government agencies; namely, the Bureau of Labor Statistics, the Office of Education, and the National Science Foundation.

It is recommended that EPA enter into negotiations with the Bureau of Labor Statistics and the U.S. Office of Education to the end that the routine processes of data collection conducted by these agencies be marginally adjusted to optimize the applicability of the data to the particulars of pollution control.

AAEE is prepared to form a standing committee to work with the Agency in identifying manpower problems and assessing needs, primarily in those areas dealing with environmental crises. The Academy also offers to EPA its assistance in developing and managing programs for manpower training that are responsive primarily to crisis situations.

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Assessment of Manpower Requirements for Water and Wastewater

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INTRODUCTION

An assessment of manpower (workforce) requirements for water and wastewater must consider not only how many workers are needed but also at what levels of expertise.

This paper reviews the development of the environmental workforce needs, identifies the factors which influence the workforce supply, examines some national workforce projections, and discusses several resources for projecting environmental workforce needs and developing workers with appropriate expertise.

Our first concerns with environmental quality began with the recognition of the relationship between water quality and public health. Recognizing the immediate and direct relationship between the quality of drinking water and the consumers health, programs were established to protect the quality of water supplies through treatment and safe disposal of human wastes and treatment for water supplies to attain potable water quality.

The establishment of water supply systems and wastewater treatment facilities resulted in a demand for individuals to operate, monitor, and regulate these facilities. With the advent of the industrial age, an ever increasing population, and the development of capabilities to recognize related environmental pollutants, the treatment of technology become more sophisticated and the facilities more numerous. The workforce needs increased accordingly demanding more individuals with very specialized and highly technical skills.

***Table 1. Legislation Pertaining to Environmental Protection**

Date	Public Law	Title
1899	33USC 401-413	Rivers and Harbors Act
1964	PL88-379	Water Resources Research Act of 1964
1965	PL89-80	Water Resources Planning Act of 1965
1966	PL89-665	National Historic Preservation Act of 1966
1967	42USC 7401 amended by PL90-148	Clean Air Act (amended in 1970-73-74-77)
1968	PL85-624	Wild and Scenic Rivers Act amended in 1972-74)
1969	PL91-190	National Environmental Policy Act of 1969 (NEPA)
1970	PL92-574	Occupational Safety and Health Act
1971	PL85-264	Fish and Wildlife Coordination Act
1972	PL92-340	Ports and Waterways Safety Act of 1972
	PL92-516	Federal Pesticide, Fungicide & Rodenticide Act (amended in 1975-78)
	PL95-87	Surface Mining Control & Reclamation Act of 1972
	PL92-532	Marine Mammal Protection Act (amended 1973)
	PL92-500	Federal Water Pollution Control Acts Amendments of 1972 (amended in 1974-75-76 and 1978)
	PL92-574	Noise Control Act of 1972 (amended in 1976)
	PL92-532	Marine Protection, Research and Sanctuaries Act of 1972
	PL92-583	Coastal Zone Management Act of 1972 (amended in 1976, 1978)
1973	PL93-205	Endangered Species Act (amended in 1976-77)

Table 1 (con't)

1974	PL93-577	Non-nuclear Energy Research and Development Act of 1974
	PL93-523	Safe Drinking Water Act (amended in 1977)
	PL93-319	Energy Supply and Environmental Coordination Act of 1974
1975	PL93-627	Deep Water Port Act of 1974
	PL89-272	Resource Conservation and Recovery Act of 1976 originally PL89-272 of 1965; (amended in 1970-73-75-76)
	PL94-469	Toxic Substances Control Act (TOSCA)
1977	PL95-192	Soil and Water Resources Conservation Act of 1977
	PL95-91	Department of Energy Organization Act of 1974
1978	PL95-604	Uranium Mill Tailings Control Act

*"An Analysis of the Role of the U.S. Environmental Protection Agency in the Development of Manpower for Water Pollution Control." by The American Academy of Environmental Engineers, July 1980.

Factors Affecting the Environmental Workforce

Two major factors impact the environmental workforce; legislation and socioeconomics. Environmental occupations are especially sensitive to environmental legislation at the Federal level.

Table 1 taken from the American Academy of Environmental Engineers 1980 Report gives a chronological listing of significant Federal environmental legislation. Water quality legislation in the 1960's created the demand for technicians to operate primary treatment facilities. Subsequent legislation required more treatment facilities and more sophisticated secondary treatment. The need was established for not only more environmental workers but for workers with more technical skills in all phases of design, operation, and regulation of water quality treatment facilities.

The upgrading and construction of new treatment facilities

under Public Law 92-500 combined with water quality standards which required treatment beyond the secondary level to establish an unprecedented demand for large numbers of individuals with highly technical skills. This demand has been further intensified by passage of the Safe Drinking Water Act (SDWA), Resource Conservation and Recovery Act (ReCRA), and Toxic Substances Control Act (ToSCA). The result is that experienced individuals with specialties in one area of the environment are hired out of that field to fill the work void in the newly emerging disciplines.

Enforcement is another side of the legislative picture. As federal, state, and local regulatory agencies combine with the public to insist that plants not only operate within established standards but they also be operated cost effectively, owners of treatment facilities will be forced to maintain a full complement of highly trained competent operating staff.

Analysis of Plant Performance

The magnitude of the problem of poor plant performance is demonstrated in the 1981 General Accounting Office (GAO) Report, and confirmed by recent EPA reports which indicate from 50 to 87% of existing Privately Owned Treatment Works (POTW) are in violation of their NPDES permits for secondary effluent discharge. As many as 31% of these violations are considered by the GAO to be serious. Over 50% of the violations reported are related to operation, management and maintenance of the facilities.

The reasons for poor performance identified by the GAO Report were the same as those identified by the Hegg Study. The three top ranked factors were (Table 2):

- Failure to apply treatment concepts and testing to process control.
- Lack of understanding of wastewater treatment.
- Quality of technical guidance available to operators.

The GAO Report and the Hegg Study emphasize the need not only for adequate staffing but more significantly the quality of the staffing. The operating staff must be highly skilled in the technology of wastewater treatment.

The socioeconomics of the environmental work force are similar to other occupations. Life patterns such as birth rate, survival to work age (health) and immigration produce the potential workforce. The supply of potential workers must keep pace with the demand for individuals with specific technical skills required to deal with replacement due to turnover, retirement, career transfers, and new hires necessary for

*Table 2: Ranking of Factors Limiting Performance
for 30 Evaluated Facilities

Rank	Factor	Times Occur- red	Times Ranked	Rank	Factor	Times Occur- red	Times Ranked
1	Operator Application of Concepts and Testing to Process Control	28	6	28	Preliminary (Design)	7	0
2	Wastewater Treatment Understanding	20	4	32	Plant Inoperability Due to Weather	4	0
3	Technical Guidance	17	5	32	Supervision	4	0
4	Process Control Testing	21	0	32	Equipment Malfunction	4	1
5	Sludge Handling Capability	18	3	32	Productivity (Operations)	5	0
6	Process Flexibility	18	2	32	Insufficient Time on the Job	5	0
7	Process Controllability	20	0	36	Insufficient Funding	6	0
8	Clarifier (Secondary)	11	2	36	Motivation (Operators)	5	0
9	Sludge Treatment	15	0	36	Flow Backup	3	0
9	Aerator	9	2	36	Level of Certification	5	0
11	Performance Monitoring	15	0	36	Housekeeping	4	0
12	Disinfection	10	0	36	Lack of Program (Maintenance)	4	0
12	Ultimate Sludge Disposal	12	0	36	Manpower (Maintenance)	4	0
14	Laboratory Space and Equipment	14	0	44	Industrial (Loading)	2	1
15	Alternate Power Source	13	0	44	Unnecessary Expenditures	4	0
15	Unit Process Layout	6	1	44	Lack of Unit Bypass	4	0
15	Policies (Administrators)	7	2	44	Plant Location	3	0
18	Infiltration/Inflow	11	0	48	Spare Parts Inventory	3	0
18	Alarm Systems	12	0	48	Equipment Age	3	0
20	Plant Coverage	10	0	50	Hydraulic (Loading)	2	0
21	Familiarity with Plant Needs (Administration)	7	0	50	Toxic (Loading)	2	0
22	Adequacy (O & M Manual)	8	0	50	Seasonal Variation (Loading)	2	0
22	Return Process Streams	8	1	54	Process Accessibility for Sampling	2	0
22	Training (Operations)	8	0	54	Lack of Stand-By Units for Key Equipment	1	0
22	Attitude (Operations)	6	0	54	Quality of Equipment	1	0
28	Number (Staff)	7	0	54	Level of Education	1	0
28	Scheduling & Recording (Maintenance)	8	0	54	Organic (Loading)	1	0
28	Flow Proportion to Units	6	0	54	Submerged Weirs	1	0
28	Working Conditions	7	0	60	Process Automation Control	1	0
28	Pay (Operators)	5	0	60	Personnel Turnover	1	0

* EPA Report 600/2-79-054, Evaluation of Operation and Maintenance Factors Limiting Municipal Wastewater Treatment Plant Performance. (Hogg, et al., 1979a)

1990 Construction Grants Strategy Task IV: Compliance Strategy Sub-task D: Local Staffing and Training Requirements

new plant construction, and plant upgrade and expansion.

Turnover is a significant factor in influencing workforce needs for water and wastewater treatment facilities. Low salary and social prestige combine to drive the turnover rate abnormally high. The Personnel Advancement Committee (PAC) of the Water Pollution Control Federation (WPCF) is preparing a report on salaries of wastewater personnel 1980. The PAC Report documents significant salary inequities between operating personnel and other service oriented occupations.

The Draft Final Report of the 1990 Construction Grants Strategy uses a national turnover average of 14%. While turnover is less in the more rural areas, urban metropolitan areas such as Baltimore and Washington, D.C. have a turnover rate of twenty percent and higher. The significance of this high turnover is that the workforce will turnover every five to seven years. This will necessitate training of a massive new workforce as well as refraining to keep pace with technological advances in treatment.

Another factor which is only just now beginning to impact

the environmental workforce is the International Communities designation of the 1980's as the Decade for Water and Sanitation for Underdeveloped Countries. An impressive number of experienced environmental workers will be involved in providing expertise in design, construction and operation of water quality treatment facilities and community education. As these more experienced individuals become involved in this international project, additional workers will be required to fill the gaps in the domestic labor market.

Workforce Projections

Given this background on the development of the environmental workforce and the factors influencing the demand, let's look at some projections. The Draft 1990 Construction Grants Strategy Report sets the existing number of treatment facilities at 15,300 plants. By 1990 this number is expected to increase to approximately 19,000 with an additional 4,000 plants anticipated by the year 2000. Priority will be given to rural areas.

The report goes on to state that treatment will involve increasingly higher technology so that by 1990 only 11.6% of the POTW will be at the primary treatment level. Over 44% are estimated to be operating at levels more stringent than secondary. Finally by the year 2000 few if any plants will still be operating at the primary level. Table 3.

The workforce demands generated by the above increases in plants and treatment technology will require workers skilled at

***Table 3: Increasing Treatment Requirements
Projected to 1990**

Type of Treatment	Current	1990	Change
— Primary	4,200	— 2,200	— 2,600
— Secondary	7,000	8,800	+ 1,800
— More Stringent Than Secondary	4,100	8,400	+ 4,300
Total	15,300	19,400	+ 41,00

"1990 Construction Grants Strategy Task IV: Compliance Strategy Sub-task D: Local Staffing and Training Requirements"

*Draft Final Report December 1980 (unpublished to date) Office of Water Programs Operations, EPA.

the occupational/vocational level and at the Bachelor and Advanced Degree levels.

At present there are no projections for the number of graduate engineers and scientists needed in the near future. There are, however, a few reports which provide some insight into the workforce needed. The first is the National Academy of Science Report on Manpower for Environmental Pollution Control (1977) (NAS Study) which projected that an additional 8,000 engineers would be required by 1985 in the wastewater area alone by just the public sector. The minimum overall increased need by 1985 was estimated to total 16,000 professional engineers.

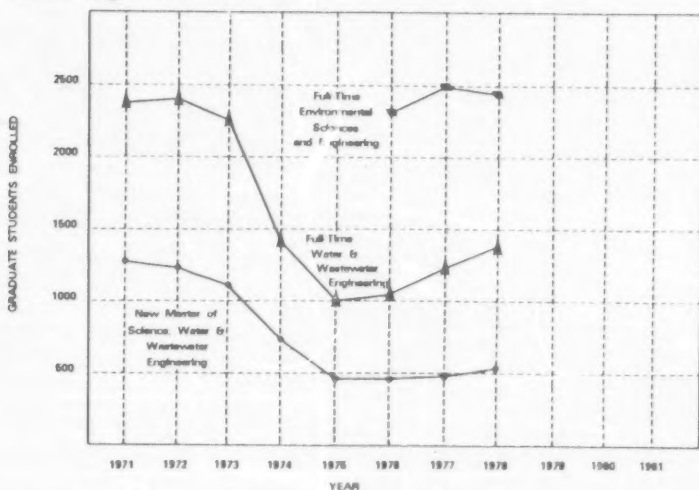


*Figure 1: Graduate Students Enrolled in Environmental Science, Water and Wastewater Engineering, 1971-1978

*"An Analysis of the Role of the U.S. Environmental Protection Agency in the Development of Manpower for Water Pollution Control" by The American Academy of Environmental Engineers, July 1980.

A report in 1975 by Middlebrooks et al. projected a shortfall of 15,000 professionals in the water pollution control field by 1980. Unfortunately there is no data readily available to show whether this shortfall has developed or not.

There are, however, the findings of the 1980 Report by the American Academy of Environmental Engineers which traces the continual decline of graduate student enrollment (Figures 1 and 2) and a drop in graduate degrees awarded, Table 4. With

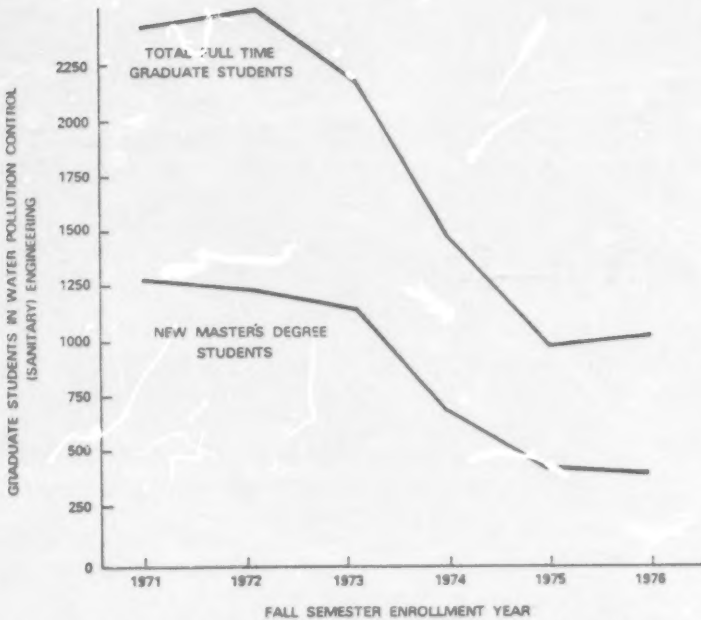


Figure 2: Summary of Graduate Enrollment in the Water Pollution Control Engineering Fields Since 1971
(*Journal Water Pollution Control Federation*)

such significant declines it is doubtful that the workforce needs projected by Middlebrooks were met.

The fact that there is a need for workers with environmental degrees at the bachelors level and above is indisputable. However, the greater need will be for workers at the technician (occupational/vocational) level. Table 5 taken from the Academy's 1980 Report provides an estimate of the number of workers in 1974 with direct employment in Pollution Control Activities.

The unpublished Draft Report of the 1990 Construction Grants Strategy projects a total of 26,200 additional workers will be needed by 1990, Table 6. Of these workers, 13,600 will be required at the operator/technician level.

Recent discussions with EPA officials in the Office of Water Program Operations presented two interesting observations which challenge the above projections. First, that the number of Advanced Wastewater Treatment Facilities will be less than

Table 4: Degrees Awarded in Environmental Engineering

Year	<u>Number of Degrees Awarded</u>		<u>Degrees/Year</u>	
	M.S. or M.E.	Ph.D.	M.S.	Ph.D.
1950-1959	2,189	248	219	25
1960-1965	1,231	185	246	37
1966-1968	739	117	369	58
1968-1969	361	97	361	97
1969-1970	396	90	396	90
1970-1971	571	96	571	96
1971-1972	804	137	804	137
1972-1973	812	101	812	101

These data reflect increasing financing and public interest.

previously expected. Second, that more plants will be automated requiring fewer but more technically skilled operators.

In contrast to the above reservations survey results of individuals in management positions in wastewater treatment facilities project a need for 2,000 - 3,000 new workers annually for the period 81-85 (personal correspondence from Dr. James O. Bryant), Table 7. These projections are for new hires and do not factor in replacement needs. Workforce requirements will be much greater when replacement needs are also considered. As many as 13,700 technicians and 30,300 skilled operators will be needed to meet workforce needs due to turnover.

Despite the recent federal legislation concerning potable water, the workforce needs in water supplies are not expected to equal the needs of the wastewater field. Even gross estimates are, however, unavailable at this time.

Resources for Workforce Needs Assessment and Development

Long range national projections are useful to gain attention but they are not too helpful at the local level. At the local level more information is necessary in terms of numbers of workers needed with specific skills. Unfortunately this information is not available as the Academy's 1980 Report observes "Our national manpower requirements are yet to be projected in terms of specific numbers for each major task category and in production rates of trained workers to meet our skilled manpower needs."

**Table 5: Estimated Direct Employment in Pollution
Control Activities
Summary Data 1974**

Occupation	Type of Employer						Total
	Federal	State	Local Government	Industry	Educational Institution	Other	
Scientists	11,400	3,800	2,200	14,900	5,500	3,100	40,900
Engineers	8,300	5,200	5,700	64,700	1,300	8,800	94,000
Technicians	1,000	2,000	20,000	25,000	NA**	NA**	98,000
Skilled Operators	4,000	NA	155,000	112,000	NA**	NA**	271,000

*National Academy of Sciences, Vol.V, Manpower for Environmental Pollution Control

**NA - indicates those areas for which data were not available

***Table 6: Projected Workforce Needs for Water Quality**

Staff	Current	1990	Change
Senior Operators and Superintendents	31,100	37,800	+ 6,700
Operators	38,300	45,200	+ 6,900
Others	42,600	55,200	+ 12,600
Totals	112,000	138,200	+ 26,200

*"1990 Construction Grants Strategy Task IV: Compliance Strategy Sub-task D: Training Requirements," by The Maxima Corporation, December 1980.

Two important concepts are embodied in the above observation. First, how many workers with specific skills are needed. Second, what are the resources available to develop these skills and how fast can they be developed.

Workforce needs both present and future require a manpower information system. The development of such a system was the object of a study in 1979. The resulting report "Maryland Manpower Information System for Municipal Water and Wastewater Facilities (MMIS)" sets in focus the information needed for planning, developing, and implementing programs to provide the properly trained manpower to operate and maintain the water and wastewater facilities of Maryland.

The MMIS Report identifies and prioritizes the types of information necessary to refine project workforce needs and identifies potential sources for this information.

The first step in this process is a review of the literature concerning EPA Manpower Management Resources.

Three basic information categories and their components are listed and the potential sources for this information are identified in Table 8, "Considerations in Manpower Management for Water and Wastewater Operations." The specific needs and type of information for each general user area are detailed in Table 9, "Potential User Needs of the Maryland Municipal Water and Wastewater Facility Manpower Information System."

The report also provides an analysis of the typical statistic gathered for Manpower Forecasts. Several specific data elements are examined and comments on the usefulness of each information item is reviewed.

***Table 7: Projected National Manpower Needs (New Hires)
to Fill Vacancies Resulting from New Construction**

Average Daily Design Flow, Q, MGD	NUMBER OF NEW PERSONNEL NEEDED					
	YEAR					
	1980	1981	1982	1983	1984	1985 and Later
$Q < 1.0$	762	1652	1652	2034	1144	2542
$1.0 \leq Q < 10.0$	445	445	461	772	642	773
$10.0 \leq Q$	190	259	240	210	201	389
All Plants	1397	2356	2353	3016	1987	3704

*Projections based on 15,161 existing treatment plants nationwide with flow distribution as reported by U.S. EPA (1978 Needs Survey).

Table 8: Considerations in Manpower Management for Water and Wastewater Operations*

Need	Component	Information From
Total Manpower	For new plants	Construction grants: 1, 2, and 5 year estimates
	For upgraded plants	
	To satisfy existing recommended staffing	Operating reports, performance reports, certification records
Training	To replace (terminations, deaths, promotions, etc.)	Operating reports, performance certification records, compliance reports
	Skills of existing staff	
	Skill needs of existing staff	
	Skills for new or upgraded plants	
Cost-effective evaluation	Training program	Operating reports, performance reports, compliance reports, certification records, training program reports
	Information system	

*"Maryland Manpower Information Systems for Municipal Water and Wastewater Facilities," Austin, John A. and Holtan, Andrew A. July 1979.

**Including considerations of geographical location, plant size, process, job categories, etc.

***Table 9: Potential User Needs of the Maryland Municipal Water and Wastewater Facility Manpower Information System**

General Area	Specific Need
Manpower Planning 1, 2 and 5-year projections	Numbers of people Scheduling for coming on-line Budget requirements Cost effectiveness Required subject area expertise ● new plants ● upgrade plants ● existing plants
Training	Scheduling Numbers of people Cost effectiveness based on ● improved performance in plants ● training delivery system Required subject area expertise ● to operate new plants ● to upgrade plants ● to correct performance deficiencies ● to improve evaluation and reporting Depth required in each subject area for each plant classification. Training resources ● courses ● funds ● delivery systems ● sponsors ● scheduling ● materials ● instructors Entry level requirements ● education ● performance ● experience

Table 9 (con't)

	Plant performance deficiencies due to
	● lack of skill or knowledge ● design ● management
Certification	Number
	● in each level ● not certified
	Advancement rates
	Terminations
	Manpower movement - employer to employer
	Matching exams with performance
	Numbers
	● requiring training ● obtaining training required
Regulatory	Compliance with
	● NPDES ● state regulations ● federal regulations ● certification ● design specs
	Qualifications of field personnel

*"Maryland Manpower Information System for Municipal Water and Wastewater Facilities," Austin, John A. and Holtan, Andrew A. July 1979

With that review of the elements of an information system required to project workforce needs, let's look at the resources available to meet our second need, determining and developing workforce skills needed. At the national level the federal government such as the USEPA National Training & Operations Technology Center (NTOTC) and associations such as the American Water Works Association (AWWA) and the Water Pollution Control Federation (WPCF) can provide resources.

Within a state there are the academic institutions with certificate and degree programs ranging from the community college to the college and university level. The state vocational/educational offices and the state water quality

regulatory agencies offer staff and in some cases financial support to develop skills in the water quality worker. Other resources include associations, not only water quality workers associations but associations for the employers of water quality workers. Certification programs, public awareness, groups and apprenticeship programs are but a few of the obvious resources. The problem is how to focus and coordinate these diverse resources on the common goal of developing a competently trained water quality workforce at a rate that will satisfy workforce demands.

A state advisory committee on environmental workforce training is an essential element to establishing and maximizing the effectiveness of a state training program to provide skilled workers as needed. In 1976, the Association of Boards of Certification (ABC) for Operating Personnel in Water and Wastewater Utilities published a project report detailing the "Roles and Responsibilities for Developing a Comprehensive State Water and Wastewater Operator Training Program."

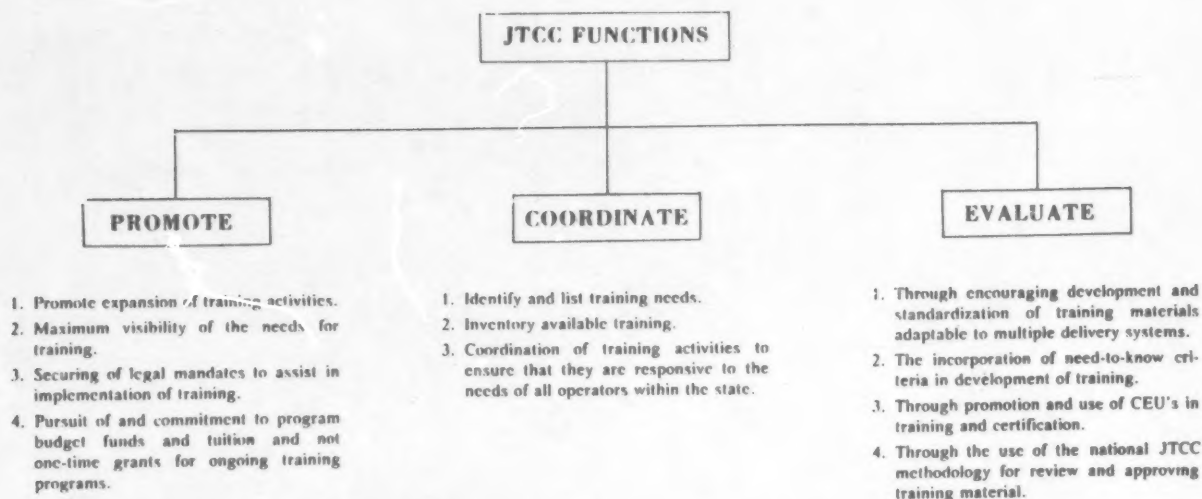
The ABC Report identifies five sections to establishing a state operator training program:

- Section I Basis for Effective Training Programs
- Section II Establishment of a Basis for Training
- Section III Development of Training Materials and Methods
- Section IV Standard Delivery Systems
- Section V Means to Provide Coordination and Control

Section V of the ABC Report encourages states to form an advisory committee which will focus attention and resources on the accomplishment of the other four elements of a state operator training program. In 1980, ABC published a project report entitled "How to Develop a State Joint Training Coordinating Committee (JTCC)." The report details the functions of the State JTCC, namely to coordinate, promote, and evaluate training, see Table 10, "Suggested Functions of A State JTCC." The steps for formation of a State JTCC are reviewed including committee representation and development of authority for existence. A comparison of several State JTCC's is provided in the "How To" Report, Table 11, "State/Province JTCC Comparisons."

The National Environmental Training Association (NETA) is an invaluable resource to the State JTCC and to the State training program. Through NETA, information can be obtained on training materials, trainers, and training programs. Services available from NETA include a Directory of Training

*Table 10: Suggested Functions of a State Joint Training Coordinating Committee



*"How to Develop a State Joint Training Coordinating Committee (JTCC)" by Joint Training Coordinating Committee, Association of Boards of Certification, January 1980.

Personnel, a Directory of Training Materials, Searches at the National, State, and local levels, instructor development and Needs Assessments to determine how well prepared a geographical area is to meet the environmental workforce demand.

* Table 11: State/Province JTCC Comparisons

Proposed Model Program	CALIFORNIA	MARYLAND	NEBRASKA	UTAH	WASHINGTON	ARIZONA
FUNCTIONS						
1. Promote expansion of training activities	X	X	X	X	X	
2. Max visibility of needs of training		X	X	X	X	
3. Securing legal mandates for training		X	X			
4. Pursuit of program budget funds				X		
5. Identify training needs	X	X	X	X		
6. Inventory available training	X	X	X	X		
7. Coordination of training		X		X	X	X
8. Encourage development of training material adaptable to multiple delivery systems	X	X			X	
9. Use of need-to-know criteria in development of training material		X		X	X	
10. Promotion of use of CEU's		X		X		
11. Review and approval of training material		X		X	X	X
MEMBERSHIP						
AWWA	X	X	X	X	X	X
WPCF	X	X	X	X	X	X
University	X			X		X
Community College	X	X		X		
Environmental Regulatory Agency	X	X	X	X	X	X
State Education Agency			X			
Municipalities		X	X	X	X	
Operating Personnel		X	X	X	X	
Certification Board	X	X		X		
Utilities		X				
AUTHORITY						
1. Advisory	X	X	X	X		
2. Administrative		X				X
3. Regulatory					X	
4. Legislative						
OPERATION						
1. Staff Training Coordinator					X	

*"How to Develop a State Joint Training Coordinating Committee (JTCC)," by Joint Training Coordinating Committee/Association of Boards of Certification, January 1980.

NETA represents a focal point for identifying, developing, and coordinating resources to meet environmental workforce needs. For example, a report in October, 1980 reviews the results of a needs survey of water quality instructors. This report provides information on availability of trainers for a specific region or state (Table 12), location of instructors with specific academic background, work experience and training expertise (Table 13), and identifying training resources in a given state (Table 14).

***Table 12: Instructor Profile—Number of NETA Members Contacted and Number of Responses**

Region ¹ /State	Number Contacted	Number Responses	Percent Response	Region ¹ /State	Number Contacted	Number Responses	Percent Response
REGION 01				REGION 04			
Connecticut	0	0		Iowa	4	2	
Maine	2	1		Kansas	0	0	
Massachusetts	10	8		Missouri	7	3	
N. Hampshire	0	0		Nebraska	2	0	
N. Jersey	2	0		Total	13	5	38.5%
N. York	13	10		REGION 05			
Pennsylvania	6	3		Arizona	1	0	
Rhode Island	0	0		Colorado	4	3	
Vermont	2	1		Montana	4	3	
Puerto Rico	1	1		N. Dakota	0	0	
Virgin Islands	0	0		S. Dakota	1	1	
Total	36	24	67%	Utah	7	7	
REGION 02				Wyoming	3	2	
Alaska	0	0		Total	20	16	80.0%
Delaware	1	1		REGION 06			
D.C. Columbia	2	0		Arkansas	1	0	
Idaho	3	2		Louisiana	6	3	
Illinois	2	2		N. Mexico	2	1	
Indiana	11	5		Oklahoma	1	1	
Iowa	0	0		Texas	7	3	
Kansas	0	0		Total	17	8	47.1%
Massachusetts	6	4		REGION 07			
Michigan	1	0		Alaska	0	0	
Minnesota	6	3		California	21	11	
N. Virginia	0	0		Guam	1	0	
Total	34	19	55.9%	Hawaii	1	0	
REGION 03				Idaho	1	0	
Illinois	22	11		Nevada	1	0	
Indiana	11	9		Oregon	9	4	
Michigan	4	2		Washington	4	3	
Minnesota	10	6		Total	38	18	47.4%
Ohio	12	5		TOTAL	225	129	57.3%
Wisconsin	8	6					
Total	67	39	58.2%				

¹**"Water Quality Instructor Needs Survey," by National Environmental Training Association, October 1980.

*Table 13: Instructor Profile—Education, Work Experience, and Training Capabilities

AREA	Educational Background				Work Experience				Training Capabilities			
	Water Supply		Wastewater		Water Supply		Wastewater		Water Supply		Wastewater	
	Number	%	Number	%	Number	%	Number	%	Number	%	Number	%
Planning	41	31.8	44	34.1	38	29.5	46	35.7	31	24.0	40	31.0
Design	47	36.4	53	41.2	31	24.0	50	38.8	23	17.8	40	31.0
Operations	58	45.0	76	58.9	56	43.4	88	68.2	74	57.4	100	77.5
Maintenance	35	27.1	47	36.4	47	36.4	68	52.7	46	35.7	68	52.7
Management	42	32.6	56	43.4	46	35.7	75	58.1	50	38.8	69	53.1
Laboratory	78	60.5	88	68.2	69	53.1	91	70.5	67	51.9	89	69.0

Total Sample: N = 129

*“Water Quality Instructor Needs Survey,” by National Environmental Training Association, October 1980.

*Table 14: Training Sources — Training of Trainers

Region ¹ /State	Training Source	Area of Instruction for Trainers ²							
		W ²	WSD	WWT	WMC	AIR	SW	HM	NS
REGION 01									
Connecticut	York Wastewater Consultants	X		X					
Mass. ne	New England Regional Wastewater Institute			X					
Massachusetts	Camp, Dresser & McKee, Inc.	X	X	X	X	X	X	X	
	Metcalf & Eddy	X	X	X	X				
New Hampshire	New Hampshire Vocational Tech. College/Berlin	X	X	X	X				
	Salem County Vocational Technical Schools	X	X	X	X	X	X		
New Jersey	Essex-County Vocational Schools	X	X	X	X				
New York	Buffalo Sewer Authority			X					
	Bureau of Training & Development			X		X	X	X	
	CDM/Alexander Potter Associates	X	X	X	X				
	City of New York Dept. of Env. Protection			X					
	Columbia-Greene Community College	X	X	X	X				
	Onondaga County			X					
	Southern Cayuga Lake Intermunicipal Water Comm.	X	X						
	State University at New York			X					
	Suffolk County Dept. of Health Services	X		X					
	Ulster County Community College	X		X					

¹META Survey Regions

²W² = Water Supply Treatment
 WSD = Water Supply Distribution
 WWT = Wastewater Treatment
 WMC = Wastewater Collection

AIR = Air Pollution
 SW = Solid Wastes
 HM = Hazardous Materials
 NS = Noise Pollution

*“Water Quality Instructor Needs Survey” by National Environmental Training Association, October 1980.

CONCLUSIONS/RECOMMENDATIONS

The need for workers in the water and wastewater field will be significant in the next decade. Workers will be required at all levels of expertise. However, even at the technician level the workers must have highly technical skills. A great deal of work remains to be done to identify not only what workers are needed but also to determine what levels of expertise are necessary. Fortunately there are several resources available to assist in this effort.

Anyone interested in determining environmental workforce needs and developing the resources to meet the workforce needs should contact the National Environmental Training Association, 158 South Napoleon Street, P.O. Box 346, Valparaiso, Indiana 46383, (219) 465-1744.

Incentives must be developed to encourage individuals to enter the field of water quality and to participate in entry level and upgrade training. Resources in the form of instructors and financial support must be developed to provide this training. This can only be accomplished if public awareness is focused on the need for well trained staff water quality workforce which can ensure water quality in a cost effective manner. Federal, state and local agencies must provide a responsible commitment and support to development of this workforce.

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Certification of Water and Wastewater Operational Personnel

**Daniel J. Campbell
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INTRODUCTION

Certification of water and wastewater operational personnel can hardly be regarded as a new development. To the contrary, today's certification programs have evolved over a period of more than fifty years. Few professionals practicing in any aspect of water supply or water pollution control would question the belief that certification has produced many benefits. We all know we are better off with certification than without it; we all know that because of certification water quality is improved, that public health is better protected, that the public's investment in facilities is optimized and safeguarded, that better qualified people function as operators and that they are better paid. We know these benefits to be true and we have succeeded in convincing legislators, governmental executives, and the public that they are true. We have succeeded so well that from the single certification program established just after World War I in New Jersey, we now have 44 mandatory wastewater programs and 41 mandatory water programs in the United States. (Figure 1)

Those of us who are responsible for these certification programs know they are well administered and effective. We know this because we have over 100,000 certificants approved by our programs who are operating water and wastewater facilities throughout North America.

The primary purposes of this paper are to call to your attention that these "truisms" are being challenged, to identify

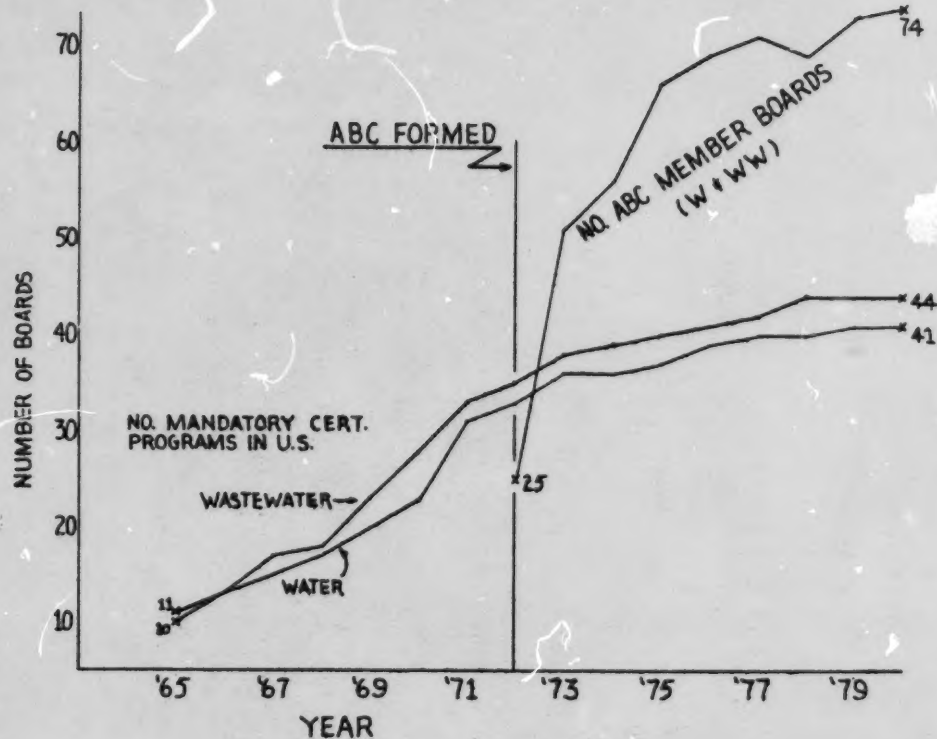


Figure 1

some of the ways in which these challenges are being responded to, and to elicit your support in meeting these challenges.

In some cases the challenges to the effectiveness of certification are indirect. We have all seen numbers of studies pointing out that treatment facilities are not performing as well as they ought. In many cases the "rap" is placed on the operator, fairly or unfairly. Placing the rap on the operator also largely places it on certification.

There are also direct challenges to certification, such as the question whether the requirements placed upon people to become certified are actually necessary for them to perform effectively. Although such challenges have to date been more potential than actual, they are a legitimate cause for concern.

There are two ways of meeting these challenges. One is through compilations of statistics to refute unjustified criticisms. Such statistics as contrasting the operation of facilities with properly qualified staff against those with less than qualified staff would be helpful. There could be several parameters used in such comparisons: treatment efficiencies; levels of compliance with standards; economy of operation and maintenance, and others. The second, and more important, is by taking positive action to assure the effectiveness of certification programs; to make sure that they are capable of achieving the benefits we know they can. Among such actions are the establishment of realistic qualifications, proper enforcement of certification regulations, and job-based examinations.

Both ways of meeting these challenges are expensive. Few certification programs command sufficient resources to do so effectively. Even if all programs were able to do so, we would then see a great many programs engaged in exactly the same work at about the same time. Fortunately, the vehicle exists for certification programs to pool resources to collectively take necessary action and gather necessary data. This vehicle is the Association of Boards of Certification (ABC).

ABC was established in 1972 with its primary purpose being to improve and strengthen certification programs through interboard cooperation and communication. (Table 1). Membership in ABC has grown from the 25 charter boards to the current number of 74. In the nine years of ABC's existence, its member boards have supported a wide range of activities to improve certification. ABC has also enjoyed the active support of EPA, both in terms of encouragement and in terms of grants to fund projects of mutual benefit.

Table 1

ABC Products	Month & Year
A Classification System for Water and Wastewater Facilities and Personnel (green book)	June 1974
A Classification System for Water and Wastewater Facilities and Personnel; Part II — Personnel Certification and Examination System (red book)	July 1975
A Classification System for Water and Wastewater Facilities and Personnel; Part III — Existing Examination Systems: A Current Status Report (yellow book)	April 1976
Role and Responsibilities for Developing a Comprehensive State Water and Wastewater Operator Training Program (brown book)	July 1976
Administrative Review of the ABC Certification System (white book)	August 1977
Model Certification Examination Procedures for Wastewater Treatment Plant Process Control (blue book)	December 1977
The Matrix Report; Water and Wastewater Training Materials Evaluation Matrix Project Step I Report	March 1979
Wastewater Collection System Personnel Examination Questions	1979
Water Distribution Personnel Examination Questions	1979
A Certification Program for Water and Wastewater Laboratory Personnel	September 1979
How to Develop a State Joint Training Coordinating Committee (JTCC)	January 1980
Wastewater Treatment Personnel Examination Questions	1980
Audit Procedures for State Certification Programs	June 1980
Validation Procedures for State Certification Tests	September 1980

Much of ABC's attention in its formative years was appropriately devoted to projects of benefit primarily to the large number of relatively new certification programs established in the mid and late sixties. As stated above, however, there are now other challenges to be met. The balance of this paper points out ways in which certification programs can act collectively to meet them.

Certification Examinations

Examination is a tool used by most certification programs, but one which needs to be used much more effectively. If used properly, examination can predetermine whether an individual is capable of functioning effectively as an operator. All too often, however, we see certification examinations based primarily on design principles and general theoretical knowledge. Examinations which do not measure the knowledges, skills and abilities an operator must apply to perform effectively on the job are useless in assessing operational capability; in fact they are in some respects worse than useless. This is so because:

1. They do not discriminate between people qualified and unqualified to function as operators — that is, they may bar qualified people and approve unqualified people.
2. They may give examinees who are in the formative stages of career development a distorted picture of the requirements of the job.
3. Because they do not discriminate properly between qualified and unqualified people, they subject entire certification programs to the risk of action from the Equal Employment Opportunity Commission.

One of the most alarming aspects of the current situation relative to certification examinations is that few, if any, programs are capable of proving that their examinations are valid measures of the necessary knowledges, skills and abilities. However, this is one area where the certification programs have initiated collective action through ABC with support from EPA.

Using material initially developed in the Criteria for the Establishment of Wastewater Technology Training Programs project and the principles of a Modular Examination System established by ABC early in its existence, ABC has postulated and is now nearing completion of validating a complete set of task statements. These are referred to as need-to-know criteria and delineate specifically the elements of an operator's job.

Separate sets, with commonality among them as appropriate, are being validated for operators of wastewater treatment facilities and collection systems and of water treatment facilities and distribution systems. (Figure 2)

ABC has already compiled several thousand questions for use in certification examinations, some of which were developed by ABC, and some of which were developed by

ABC NEED-TO-KNOW MATRIX				
MODULE	SPECIALTY			
	WASTEWATER TREATMENT	WASTEWATER COLLECTION	WATER TREATMENT	WATER DISTRIBUT'N
GENERAL	TASK STATEMENTS			
SUPPORT SYSTEMS	SPECIFIC TO EACH MODULE AND SPECIALTY			
PROCESS CONTROL	AREA - FOR EACH OF			
TECH. SUPERVISN/ MGMT.	4 LEVELS			

Figure 2

various certification programs. ABC is now completing the strategy by which the need-to-know, the existing pool of questions, and questions yet to be developed will be tied together as key elements of an examination service.

Thus the certification boards acting together should shortly be in a position to obviate or successfully respond to challenges to certification examinations.

Audit and Technical Assistance

Examination is not the only element of certification programs requiring positive action to assure that the objectives of certification are being met. ABC has dealt with many of these other elements in considerable detail. A number of reports have been disseminated which contain ABC recommendations on most major elements. ABC is now preparing programs of audit and technical assistance which should be of major benefit to certification boards in determining and improving the effectiveness of their programs in dealing with these other elements. With the assistance of an externally conducted program audit, certification authorities can accurately assess the effectiveness of each element of their programs as well as the overall effectiveness. With technical assistance, they can address and correct deficiencies.

Following are a number of certification program elements in which existing ABC products and/or future ABC services should be of assistance to certification boards.

Elements of Certification other than Examination

Legal Aspects — Mandatory certification programs have their foundation in law. In June, 1974, ABC endorsed a model law developed by the Council of State Governments. This law should serve as a standard with which the laws creating the various certification authorities are compared.

Rules and regulations with the force and effect of law are promulgated by executive agencies to effectively administer the law. These rules and regulations establish classification systems, provide for or prohibit reciprocity, and establish administrative procedures. One aspect of a self-audit or external audit of certification programs should be a review of the legal bases of certification using ABC reports as guides.

Classification

Classification has long been recognized as a fundamental element of certification programs. The classification systems

used normally require that an operator must be certified at a specific level or grade in order to operate a facility or system of the corresponding level or grade. The qualifications which an individual must possess are progressively more stringent as the facility or system becomes larger or more complex.

ABC has recommended personnel and facility/system classification systems in several of its earliest reports. As stated in these reports, the recommended classification systems "must be viewed as dynamic — requiring periodic reviews and modification". We are now at a time when a major review must be made of these classification systems. This is true of the personnel classification system in that we must assure that education, training and experience requirements are job-relevant. It is true of the facility/system classification in that we must assure that the distinctions among the various levels or grades are genuine and that they actually necessitate differing personnel qualifications.

With any necessary modifications, the ABC classification systems will provide an excellent model for various boards to use in refining their own systems.

Training

Operator training is not merely an element of operator certification and should not be viewed as such. In fact, ABC has recommended strongly that operator training and certification programs be administered separately. One of the primary reasons for this is to avoid the mistake of training people simply to pass a certification examination.

Once this distinction has been made, however, it must be recognized that there is an interrelationship between operator training and certification. This interrelationship has been clarified by ABC in the Report: *Roles and Responsibilities for Developing a Comprehensive State Water and Wastewater Operator Training Program*. This Report states: "... the functioning of training systems requires (1) the input by the certification boards of 'need-to-know' criteria in terms of their classifications of plants and grades of operators, (2) the utilization of these criteria to establish the basis for instruction, (3) the development of materials and methods to facilitate delivery of the required instruction, and (4) the provision of training through a state system for coordination and control."

The set of need-to-know task statements referred to earlier should be used as the foundation for training systems as well as certification examination. Use of the need-to-know will

assure that training is job-relevant. It should also enhance the necessary coordination between training and certification while enabling them to be maintained separately.

The Report referred to above also recommends establishment of national and state training coordinating committees. ABC is a member organization of the Joint Training Coordinating Committee (JTCC), and supports its efforts, which include promotion of State training and coordinating committees.

Record-Keeping

It is essential to effective administration of certification programs that data be maintained. This will enhance proper planning for examinations, identification of certification trends, assurance that applications are handled in a timely manner and establish other administrative benefits.

Record-keeping is also *prescribed* for compliance with EEOC guidelines. Records must be maintained for use in assessing the extent of any adverse impact imposed by the certification process upon protected groups.

Enforcement

Enforcement needs to be addressed from several perspectives. First is that the requirements for certification should prevent unqualified people from being assigned responsibility for operation. Second is assuring that there are qualified people at all facilities. Third is that it may become necessary to revoke certificates. All perspectives must be addressed by an effective certification program.

CONCLUSION

The stated purposes of this paper were to call attention to some of the challenges to our basic beliefs about the effectiveness of certification, to identify some responses being made to such challenges, and to elicit support in meeting these challenges. Preceding sections have attempted to address the first two purposes, although the nature of the challenges were certainly not exhaustively covered. Such items as certification in the context of toxic and hazardous wastes are beyond the scope of this paper.

In the preceding sections some of the elements of certification required for an effective program were discussed. Examinations must be valid predictors of capability to perform *on the job*: certification programs must be rooted in sound laws

and regulations; classification systems must accurately establish the qualifications necessary for an individual to function effectively *on the job*; training systems must be based upon what the operator needs to know; records must be maintained; enforcement must be a reality. Certification programs must conduct self-audits or external audits and will often need external technical assistance to effect necessary program adjustments in the most cost-effective manner.

All of these actions are costly, even if the economies of performing them collectively through ABC are achieved. In the case of examinations alone, a 1977 estimate of annual cost of effective certification examinations if each State operated independently was over \$400,000. By operating collectively, it was estimated that this could be reduced to under \$100,000.* This is still approximately four times the annual dues received currently by ABC.

Throughout its history, certification of water and wastewater operators has been regarded as sort of an "overhead" item in environmental programs. This is a misconception. Certification is an essential, integral part of any State's water supply and water pollution control programs. It is up to you who are respected professionals in the field to remind elected officials and agency administrators of this fact. It is up to you to help certification boards and administrators acquire within your own State the resources needed to maintain an effective certification program.

*ABC Report: *Administrative Review of the ABC Certification System*, August 1977.

Superfund—Implications for Workforce Development and Training Center

**Joseph Bahnick
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INTRODUCTION

My topic covers "The Comprehensive Environmental Response, Compensation and Liability Act of 1980" Public Law 96-510. A public law with a title like that needs an alias. We call it "SUPERFUND".

Superfund will have a significant impact on workforce development and training in the environmental field. The law will impact the Federal, State, local and the private sector workforce.

I have a copy of an EPA National Advertisement on my desk which states:

- EPA has career opportunities for
 - Environmental, Sanitary, Chemical and Mechanical Engineers
 - Geologists, Hydrogeologists, Hydrologists
 - Environmental Scientists, Chemists and Soil Scientists
- Locations—Washington, D.C. and EPA Regional Offices
- Two Hundred Good Men and Women Needed by EPA

Before you sell your house, quit your job, or even submit a SF-171 to EPA, I need to inform you that this ad ran nationwide, several years ago, to fill job openings in EPA's Resource Conservation and Recovery Program (RCRA). The ad drew a response of 6,000 applications for 200 job openings.

If we were to recruit nationally to staff the Superfund program, EPA would run a similar advertisement for essentially the same types of professional disciplines.

I am sure you are all aware of the freeze on Federal hiring. To date, EPA may have to reprogram positions and people from other EPA programs to staff-up Superfund. Currently no exception to the freeze has been made for Superfund.

I mentioned the ad to emphasize two points

1. Superfund will be competing for the same professional disciplines, as RCRA and to some extent, programs involved in the Toxic Substance Control Act (TSCA).
2. A response of 6,000 for 200 jobs may indicate the number of people with required skills are available in the national workforce.

Point One—the competition for professional disciplines will exist at the Federal, State, local levels and in the private sector.

Point Two—the numbers of professional disciplines available—I'm not sure. However, we already have indications that skills for hazardous material field work may be in short supply.

EPA's major contractor for hazardous substance spills and abandoned waste sites field work has developed a staff of approximately 250 professionals.

Recently EPA requested the contractor to expand its staff to handle additional hazardous substance spills field activities. The contractor may have to hire professionals with very little or no experience in hazardous substance spills field work. The contractor may also have to hire technicians in lieu of professionals for field activity positions.

This is an early indication that professionals with experience and skills in hazardous substance field activities may be in short supply. The implication for training is clear. If contractors have problems hiring and developing skilled staff, so will EPA, and the States, and local agencies.

Superfund Workload Analysis

The Environmental Protection Agency made a preliminary workload analysis for Superfund in FY 1980. This analysis was based on spills data available at that time and on limited experience in abandoned hazardous waste sites. The analysis indicated a need for 1,300 EPA work years and 1,200 contract work years, annually, over a four year period. These work years would result in cleaning up 8,000 spills and 1,500 abandoned waste sites. Most of the field work would be done by contractors.

At this point in time, I would estimate that approximately

5,000 to 8,000 people will be involved in overall hazardous spills and abandoned waste sites activities over the next five to ten years.

The Problem

What's the problem? Why the need for this workforce requiring skills in dealing with hazardous substances?

Love Canal resulted in the first major public outcry. Other sites have created major public concerns around the country:

- Verona, Missouri—Dioxin drums on a farm
- Valley of Drums, Kentucky; Stringfellow, California.
- Toone, Tenn; Gray, Maine; Montague, Michigan
- Chemco fire—Elizabeth, New Jersey

EPA's Hazardous Waste Task Force identified over 700 sites with serious damage or threats of damage to health or to the environment. Attachment I displays the geographic location of these sites. An early assessment by one of EPA's consultants indicates from 30,000 to 50,000 abandoned waste sites may exist nationwide.

The Office of Solid Waste indicated that 90% of hazardous wastes generated are disposed of in an environmentally inadequate manner. RCRA lists approximately 47,000 firms as generators of hazardous wastes. There are 9,700 firms transporting hazardous wastes. Nationwide, there are over 30,000 treatment, storage, and disposal facilities.

Recently, news accounts indicated organized crime may be mixing hazardous wastes with municipal wastes in the New Jersey-New York areas.

Last month, EPA's Region II Office investigated a site located near McAdoo, Pennsylvania. The site is at an intersection along Interstate Highway I-81. They found drums with metallic sodium, picric acid (used in explosives) (picric acid crystals explode with ease), chlorinated hydrocarbons and other toxic liquids. The drums were dumped in a field—no protection.

Last week, a holding pond at a lumber perserving firm in Culpeper, Virginia released liquids containing chromium and arsenic to a small stream leading to the Patuxent River. Fish in the stream, and cattle in fields along the stream, died.

We must also deal with approximately 12,000 oil spills that occur annually. EPA is estimating that hazardous substance spills will increase from approximately 3,000 in 1980 to approximately 8,000 in 1983 and 1984.

That's the problem. The public outcry is increasing. Citizens



Figure 1

are concerned nationwide. This public concern has resulted in the enactment of Superfund—PL 96-510.

The Superfund Bill IS THE FEDERAL RESPONSE TO THE PROBLEM

The Superfund Bill (PL 96-510) authorizes:

- \$1.6 billion Trust Fund over 5 years
- Federal removal of hazardous discharges and emergency response
- Federal/State program to remedy/contain abandoned waste sites

It does not cover:

- 3rd Party damage claims
- Oil spill response.

The Federal emergency responses for spills or sites are limited to \$1 million per action within a six month time period. After those limits, the State must become involved and pay ten percent of costs involving remedial actions. Approximately 90 percent of the \$1.6 billion will be financed by industry taxes on chemical feedstocks, etc.

EPA is authorized to implement parts of the Superfund Bill through an executive order signed by President Carter. The new administration is currently reviewing the executive order.

The Superfund Bill also requires an amendment to the National Contingency Plan which outlines the roles and responsibility of Federal agencies involved in hazardous response actions. Twelve Federal agencies are involved in the National Contingency Plan. Key agencies are DOT—Coast Guard; The Department of Justice, Defense, Interior, The Federal Emergency Management Agency (FEMA) and EPA.

The National Contingency Plan provides for a National Response Team and Regional Response Teams. It also provides for On-Scene Federal Coordinators (OSC) to manage response actions on site. The Coast Guard assumes the OSC role for oil spills in coastal waters. EPA provides the OSC for inland hazardous response actions.

I mention the On-Scene Federal Coordinators (OSC) position because they are the people who make *major* decisions including evacuation of people when necessary. The number of On-Scene Federal Coordinators will increase. Highly specialized training and on the job experience will be required by the new OSC's, both at the Federal and State level.

Superfund Program Operations

The Superfund Bill provides resources for Federal emergency response actions and for long-term remedial actions.

• For hazardous substance spills, program operations include the following: (Figure 2)

- Discovery and notification
- EPA directed removals on-scene
- EPA monitored removals by responsible party
- Recovery of costs and penalties

For abandoned hazardous waste sites, program operations include the following: (Figure 3)

- Discovery and notification
- Preliminary assessments
- On-site inspections
- Emergency response actions
- Long term remedial actions
- Design, construction, operation and maintenance of containment facilities
- Long term monitoring of sites
- Recovery of costs/penalties

These activities basically describe the work to be done to

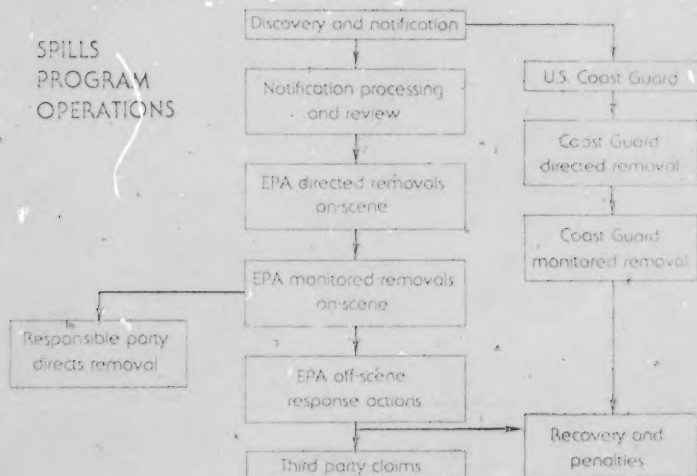


Figure 2

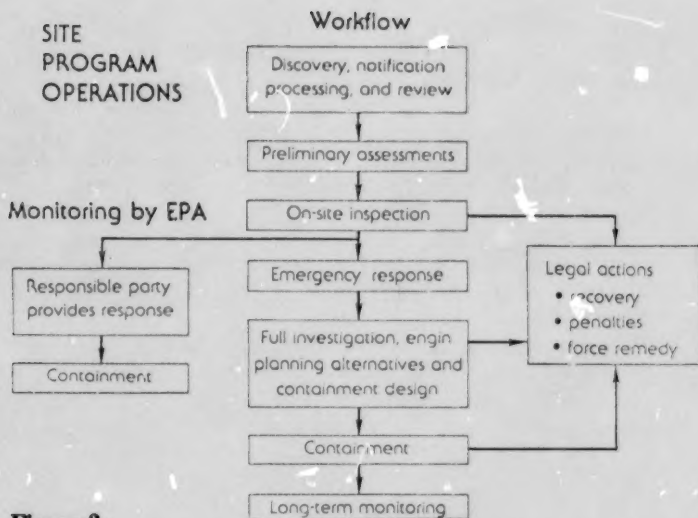


Figure 3

provide emergency response to hazardous substance releases (spills) and to clean up abandoned hazardous waste sites. We will need a trained workforce at all levels of government and in the private sector to do the job.

Workforce Impact

The current workforce estimate:

- EPA has approximately 250 people working in the Superfund programs. The Coast Guard has approximately 150 people working primarily on oil spills.
- The States may have from 400 to 500 full or part time people working on hazardous waste activities. State staff probably work on both RCRA and Superfund activities. New Jersey and a few other States may have staff dedicated exclusively to hazardous sites work. Contract field work for EPA is currently done by Ecology and Environment, Inc., of Buffalo, New York. E & E has approximately 250 people working on emergency response and abandoned waste site investigation activities.
- I have no sense of the number of people working on hazardous substance spills or abandoned waste sites in other part of the private sector.

In FY 81 and 82, Superfund will provide resources as follows:

- EPA has requested 140 positions for FY 1981 and 635 positions in FY 1982.
- The States can develop Superfund programs under cooperative agreements and contracts with EPA. The number of people required by the States will depend upon the desire of States to undertake the program.
- Superfund will also provide considerable resource dollars for EPA and the State to contract field work to the private sector. I can only guess that several thousand people will be required for Superfund contract work.

EPA is currently revising the workload analysis estimate and pricing factors. This effort will provide the basis for EPA allocation of resource between Washington and the Regions. We will also get a better estimate of workforce requirements for State and local agencies and for contract services in the private sector. In addition, when FY 1981 Superfund appropriations are available, we hope to use some funds for a demand/supply workforce/training needs assessment.

Training Impact

As I indicated before—(RCRA AD) Superfund programs will require professional disciplines as follow:

- Environmental, Sanitary Chemical, Mechanical Engineers, etc.
- Geologists, Hydrogeologists, Hydrologists etc.
- Environmental Scientists, Chemists, Soil Scientists, etc.
- Technicians will be required in these same disciplines.

In addition, the construction industry workforce (i.e., equipment operators, laborers, etc.) will be required.

Again, the numbers of people with these disciplines may be available in the existing workforce.

However, I would question the availability of the specialized skills required to work at hazardous substance spills or on abandoned hazardous waste sites.

At this point, I must raise the concern for the health and safety of people working at hazardous emergency response actions in the field.

The word hazardous does not only characterize the substances/materials found at abandoned waste sites. It also characterizes the clean-up job. The work of cleaning up spills, and containing abandoned sites is "Very Hazardous". I repeat "Very" "Hazardous".

Unless the sites investigation team knows precisely what

materials are on the site and other site conditions, the team will conduct tests for explosive vapors, oxygen deficiency, radiation sources, hazardous or toxic vapors.

The need to protect the health and safety of personnel working at hazardous waste sites/spills is specified in the Bill.

EPA's top priority for Superfund training is in personnel protective equipment and safe field operating procedures.

Dr. Ray Harrison from Vanderbilt University provides a three hour session on toxicology during one of our safety training courses. He talks about teratogens, mutagens, carcinogens, *per contaneous vapors*. The vocabulary is strange. When he describes what these words mean, it is frightening. Trainees are left with no doubts for the need to wear protective equipment and follow safe operating procedures.

We have two entry-level training courses related to personnel protective equipment and procedures. We are developing spills and sites field safety operating procedures and the use of equipment to analyze the conditions on a site.

In addition we will need to develop courses to train new team leaders in safe field operating procedures. This will include:

- Assessing levels of requirements for personnel protective equipment
- Decontamination procedures
- Developing a safety plan for each site operation
- Training team members in safe field operating procedures.

In addition to safety training, we need to develop the following technology courses:

- Sites/Spills Technology for Emergency Response
- Analytical Procedures on Site
- Containment/Remedial Action Technology
- Facility Operation and Maintenance and Long Term Monitoring

EPA currently conducts six courses at, the National Training and Operational Technology Center (NTOTC) in Cincinnati, Ohio or at Edison, New Jersey. These courses provide a base for developing the Superfund Training Curriculum. These courses are listed in the NTOTC Schedule of Training Courses. They are:

- Introduction to Hazardous Materials Incident Response
- Personnel Protection and Safety
- Incident Mitigation and Treatment Methods
- Field Monitoring and Analysis of Hazardous Materials
- Hazardous Material Incident Response Operations
- Hazardous Evaluation and Environmental Assessment

In addition to developing the Superfund training curriculum to develop skills in the Superfund workforce, we will require work in other training activities:

- Training materials development
- Media
- Training delivery systems
 - NTOTC-ERT
 - By Contractors
 - Self-paced training
 - due to limited travel resources at Federal/State Agencies, we must put the course on the road when possible.

Without question, we also must address the need for instructors to effectively teach skills and knowledge through these training courses.

As in the case of Water Pollution Control Training most of the instructors will be practitioners in the field. To become effective instructors, they need to become skilled in Instructional Technology.

Again through workforce/training needs assessment, we hope to develop requirements for:

- Curriculum Development
- Instructional Materials
- Media Needs
- Delivery Systems
- Instructors

At the University undergraduate/graduates level, we will explore the need for specialized curricula related to Superfund programs and to the possibility of providing fellowship programs to support the development of State/local agency staffs.

SUMMARY

These are the impacts of the Superfund program on workforce development and training as I view them at this point in time.

We hope through workload analysis and workforce/training needs assessments, information can be generated to guide the development of sound workforce, recruitment, development and retention practices and programs to train the workforce.

RCRA Subtitle C Training: Turning Confrontation Into Cooperation

**Paul A. Erickson
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INTRODUCTION

The decade of the '80s, like the decade of the '70s, begins with the implementation of a major piece of environmental legislation which requires extensive training in both the regulated and the regulating community. In 1970 we were just beginning to sense the breadth and depth of training required to achieve the objectives of the National Environmental Policy Act (NEPA). While the challenge of NEPA has yet to be fully met, we turn now to the challenge of the Resource Conservation and Recovery Act (RCRA) and, more specifically, of Subtitle C of that Act.

To focus on NEPA and RCRA as historical touchstones in environmental training is not, of course, to diminish the importance of training undertaken as a result of other legislation and/or Executive Orders pertaining to environmental attributes and/or resources, including water and air quality, noise, wildlife, habitat quality, floodplains and wetlands. Rather, to focus on NEPA and RCRA at this particular time is only to underscore two facts about these Acts which, I believe, can help define and direct current training efforts on behalf of the effective and safe management of hazardous waste.

The first fact is that the real world objectives of both pieces of legislation are basically simple. Regulatory jargon and room rhetoric to the contrary, the objective of NEPA is to improve (by considering environmental effects) decisions made by Federal agencies. The objective of Subtitle C of RCRA is to

manage hazardous waste so as to protect the environment and human health. In neither case is "paper compliance" with the rules and regulations a sufficient end in itself. In neither case is the measure of success anything else but, on the one hand, better decisions and, on the other, safe management practices.

The second fact is that the attainment of the simple objectives of both NEPA and RCRA require consideration of extremely complex and intertwined social, economic, scientific and engineering issues—issues which, in the real world, cannot be simply analyzed according to the myopic paradigms of individual disciplines but which, contrarily, must be evaluated from an interdisciplinary perspective. In short, in both NEPA and RCRA the most sophisticated scientific or engineering approach is likely to be absolutely irrelevant if it does not take due account of social and economic realities. Similarly, the best economic approach is likely to be absolutely irrelevant if it is not integrated with social, scientific and engineering realities.

How to balance the complexity of social, economic, scientific and engineering considerations with the simplicity of legislative objectives—that was and is the challenge of training undertaken under NEPA. It is and it will remain for some time the challenge of training undertaken under Subtitle C of RCRA.

A Relevant Parable from the '70s

It is axiomatic that good training programs can be successful in getting people to comply with "the law". It is also true, but hopefully not so axiomatic and certainly not so publicized, that compliance can be counter to the actual objectives of "the law".

For example, among professionals involved with NEPA mandated impact assessment the story is often told of a certain highway project. This particular project involved the new construction of a major highway having a relatively wide median strip. During the design phase (and in the spirit of NEPA) an interdisciplinary team was formed to design the median strip.

In the course of the team's deliberations, experts primarily concerned with vehicular safety suggested that the median strip be planted with a shrub which would absorb vehicular impact with relatively low risk to human injury. Others who were primarily concerned with aesthetics suggested that the shrub species be selected also for the aesthetic quality of its flowers. Lastly, experts who were primarily concerned with wildlife suggested that the shrub species be selected also for the value

of its berries as food for local bird populations. In the end, the team selected a shrub species which met all of these criteria, and that species was duly planted within the median of the new highway.

Within a short time, the interdisciplinary team was rightfully pleased with their decision. The safety of the new highway was well documented, the public was enthusiastic over the prettiness of the flowers, and numerous bird populations in fact used the shrubs' berries as food. Unfortunately, the team's pleasure was short-lived.

What happened was that the region experienced a drought. While the drought was minor, it was sufficient to cause that particular species of shrub to undergo an unseasonal wilt.

Also, its berries began to ferment before they fully ripened. And, finally, like those cows depicted by Robert Frost as inebriated with rotting apples, the birds that ate the fermenting berries became intoxicated. Thus the highway right-of-way was invaded by meandering swarms of drunken birds. Vehicular accidents increased. Road-kill of birds increased. Suddenly an apparent environmental success had become an actual disaster.

Now, under NEPA, the design approach which was utilized (which was an interdisciplinary approach) was eminently correct. Yet, with respect to the objectives of NEPA, that approach failed. In this particular case, the objectives of NEPA were, in fact, thwarted by the limits of the botanical knowledge of the team. With respect to RCRA, the consequences of actual failure (in spite of apparent compliance with regulations) are infinitely more severe. With respect to RCRA, we must therefore ensure not only compliance with regulations, but also that such compliance is actually consonant with the objectives of RCRA.

It is clear that there are numerous factors which can thwart the actual attainment of the objective of Subtitle C of RCRA and which therefore should become the focus of current training efforts.

Subtitle C Training: Some Considerations

Key factors which can actually thwart the attainment of objectives under Subtitle C of RCRA include:

- compartmentalization of knowledge of RCRA regulations
- polarization of interests and/or attitudes
- perception of training as one-way communication

Compartmentalization of Knowledge of RCRA Regulations

Successful implementation of Subtitle C of RCRA requires an integrated understanding of technical and procedural requirements of the cradle-to-grave approach to hazardous waste management. The technical and procedural requirements in Subtitle C are, in fact, overwhelming to anyone who reads them for the first time or even for the tenth time. In fact, the degree to which knowledge and understanding of any one facet of RCRA requirements has become compartmentalized is so great that one's having a practical, working knowledge of one area of the regulations almost guarantees that one will be ignorant of other areas. Thus, from a training perspective, *there is clear need to present generalized as well as particular training. It is also clear that such training must be given both to the regulating as well as to the regulated communities.*

For example, generators and transporters under RCRA as well as RCRA inspectors (Federal and State) must have specific understanding of the requirements of the Department of Transportation's Hazardous Materials Transportation Regulations; generators and transporters should also have an overview understanding of how treatment, storage, and disposal (TSD) facilities are regulated under RCRA. RCRA inspectors must understand not only those specific items included on their inspection checklists, but also (ideally) should be able to advise generators or owners and operators of TSD facilities as to possible advantages under RCRA of resource recovery alternatives.

Polarization of Interests and/or Attitudes

The scope and complexity of Subtitle C regulations are such that only a cooperative effort between the regulating and regulated communities will ensure the actual safe management of hazardous waste. The "black hat, bad guy—white hat, good guy syndrome" which has so often characterized regulatory efforts has absolutely no place under RCRA. The object is to protect the environment and human health—not to levy fines or otherwise substitute bureaucratic and/or political maneuvering and posturing for actions which directly affect the safe management of hazardous waste.

The regulated community must understand the needs of the regulating community and vice-versa. Both must act in light of precisely the same knowledge and understanding of effective and efficient hazardous waste management in a complex society. Thus, *training under RCRA must focus on attitudinal as*

well as behavioral objectives which will enhance cooperative management of hazardous waste and which will also minimize needless confrontations between the regulators and the regulated.

Perception of Training as One-Way Communication

Most of us understand that any new technical or scientific effort (e.g., space flight; organ transplants, etc.) will require "tinkering" or even major modification before it becomes successful. Yet, when it comes to governmental regulations, few involved in government seem to appreciate the fact that even so called final regulations will also likely be revised before legislative objectives are actually achieved.

The simple fact is that existing regulations under Subtitle C of RCRA must now be tested in the real world. Where failures are detected, the regulations should rightfully be revised to ensure attainment of the objective of the law—i.e., protection of the environment and human health. Training is a key mechanism for providing feedback to those who formulate regulations and who are ultimately responsible for providing regulations that work. *A training program under RCRA which only serves as a one-way communication link between the regulator and the regulated is therefore clearly inappropriate.* After all, as professional trainers know full well, in a good training program the trainer often emerges from the program as the trainee.

So What?

I have stressed that training under RCRA must:

- include general as well as specialized training
- be given to both the regulating and regulated communities
- enhance cooperation between regulating and regulated communities
- minimize needless confrontations between regulating and regulated communities
- serve as a feed-back mechanism for refining existing regulations to make them more effective and efficient.

It cannot be denied that these are idealistic objectives. But so is the objective of Subtitle C of RCRA. The point is that we must not approach the training needs of RCRA as if they were ordinary. They are not ordinary at all. Subtitle C of RCRA goes to the very heart of a modern technological society. The challenge presented by Subtitle C is therefore extraordinary.

Among us who are knowledgeable of current training efforts with respect to RCRA, there is little doubt that the private training sector has responded enthusiastically to RCRA by providing a wide range of seminar, workshop, and classroom instruction. Universities, colleges, and junior/community colleges are also beginning to institute a wide variety of training programs which deal with RCRA and hazardous waste management. Literally, thousands are being trained. But, so what?

Is all of this training going to result in the safe management of hazardous waste? Or is it just possible that, like much of the early training that was done under NEPA, it is primarily useful as a means for providing job-security for trainers in the private sector?

My own belief is that a government which formulates complex regulations has the responsibility to explain those regulations to the regulated community; that government's explanation should not be given simply in the format of a public information hearing, but also in a format which specifically ensures that governmental edicts will be translated into specific workplace procedures; and that the obligation of government to inform the regulated community in a meaningful, practical manner (and, likewise, to be so informed) should not be totally delegated to those who have neither the responsibility for formulating regulations nor the responsibility for making them work.

In light of these considerations, I believe it is time for the U.S. Environmental Protection Agency's Office of Solid Waste (OSW) to expand its current Industry Assistance Program, with particular emphasis on providing industry with practical instruction and/or training materials on RCRA Subtitle C. Such instruction and/or training materials should include, at a minimum, the type of training which OSW is currently providing to Regional EPA personnel under its Integrated Subtitle C Training Program. This approach would help ensure that the regulating and the regulated communities will be working from the same knowledge-base with respect to Subtitle C regulations. It would also be a significant step toward the necessary transformation of governmental-industrial confrontation into cooperation.

Solid Waste-Manpower Requirements and Training

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INTRODUCTION

Solid waste management was one of the first services provided to the public by government and industry. Early in man's urbanized society it became apparent that from time to time the streets needed to be cleansed if traffic was to move about. Public cleansing began, therefore, in response to urbanized man's needs. Initially, the disease causation relationships between solid wastes and public health was neither known nor understood. The initial concern therefore was one of public cleansing.

The early solid waste management practitioner was, in many instances, the rag picker and the hog feeder. This type of service created, in the minds of the populace, a certain viewpoint of what it took to deal with solid waste. The image of the solid waste worker therefore was one of an individual clearly on the lower rungs of society. Consequently, the business of solid waste management was not viewed as one requiring unique skills or qualifications. Therefore, no formalized training or skills were considered necessary to provide this vital public service.

The classic viewpoint of solid waste management to this day, in the eyes of much of the public, has not changed. The open burning dump and the collector on the back of the collection truck is what the public perceives solid waste management to be. Fortunately, the open burning dump is becoming an obsolete practice in the U.S. In the first four decades of the 20th century we saw a number of technological advances in the solid waste management field. Incineration of solid waste was advanced to a point where we had several hundred of these facilities in the U.S. Hog feeding continued to be a very common practice, but the relationship between certain parasitic

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diseases resulted in the development of cooking techniques. While these developments may not sound very exciting, they clearly demonstrated that the "refuse" business was slowly evolving into a field with some technological advances.

Development of Landfill

The late 30's and 40's saw the development of the sanitary landfill. This technology was directed at eliminating the open burning dump and providing a disposal technique that would be environmentally acceptable. At the time of the development of the sanitary landfill, environmental quality was not of national concern. The relationship between fires, disease vectors and public health was certainly understood however, and the sanitary landfill was developed to address those relationships.

Following World War II, our entire approach to the use of materials changed dramatically. The full development of our natural resources and those of the rest of the world and the emergence of the packaging industry and fast food industry changed not only how we lived and what we ate, but also how we viewed solid wastes. Prior to this evolution there was a serious attempt to view our solid wastes as a resource. The secondary materials industry was a vital factor in reducing the amounts of solid wastes going to incinerators, open dumps and sanitary landfills. Whether one can support the concept of hog feeding or not this practice was also directed at the reduction of our solid waste stream.

This changed dramatically beginning in the late 40's and reached MACH speed in the 50's. It became far cheaper to make it and throw it away than to save it and reuse it again. The end result was a dramatic increase in the amounts of solid wastes coming into the management systems of our urbanized society and the steady decline of resource recovery.

The dependence on our land disposal facilities and incineration systems far exceeded our ability to add capacity. This shortfall of capacity was further exacerbated by the unwillingness of the political forces of local government to expend increased and needed dollars for facilities to deal with materials with little or no value. Therefore, as we moved from the decade of the 50's into the decade of the 60's, the solid waste management field was, for the most part, not able to deal with the demands of our society.

The mind set of the American public still viewed the solid waste management practitioner as a rag picker and hog feeder. The technologies being applied to the problem were not keeping pace with the rest of the exploding technological revolution in the U.S. The systems were not able to keep up with the dramatically increasing solid wastes loads coming out of our ever increasing

affluent society. The men and women working in the field were not able to find the answers they needed to respond to the needs of this vital public service.

The difficulties of the practitioner in solid waste management in this period of time included the almost complete lack of means or methods to train needed personnel. Solid waste management was at that time, and still is, for the most part manpower intensive activity. Collection services for residential solid waste in our heavily congested urban centers required a tremendous number of hands to pick the trash up and get it into the collection vehicle. Even with the evolution of the packer body for collection, this technology was not directed at making the job particularly easier for the collector or reducing the labor force. Rather, the packer body evolved in order to get more wastes into the vehicle between trips to the disposal facility.

Other factors also created difficulties for the development of people to work in solid waste management. While a community might spend considerable money to build an incinerator, they were not willing to spend money for the operation. This lack of investment in the operational aspects of these and other facilities also included an unwillingness to pay salaries that would create career opportunities in the solid waste management. The end result was the creation of jobs open only to those with the least skills and education.

During the 40's and 50's, however, there was an awakening by a small group of people working in the field that their work was more than just a means to keep our cities clean. Within the public works field, efforts were made to develop manuals and guidance documents that could be used to improve practices and procedures in the operation of solid waste management systems.^{1,2} These efforts were sorely hindered by the lack of factual and measurable information which could be made available to the practitioner. In most instances, the data and material that was provided was from the experiences and background of a few. There was no data base.

Environmental Movement

The emergence of the environmental movement in this same period of time had a number of impacts on the solid waste management field. The air pollution control program essentially brought about the closure of almost all incinerators in the U.S. The air pollution control program also brought the elimination of much of the open burning at land disposal facilities. Therefore, there were both positive and negative impacts. The closure of the incinerators mean more wastes were going to land disposal facilities thereby creating a system overload. The elimination of

open burning also meant that the sanitary landfill became a more standard practice in many of our cities. Cities were, however, unable to secure adequate financing for these facilities in many instances. In addition, there was an increased demand for trained people to work these facilities. However, there was no training program available to send people to be trained.

The water pollution control program impacts were not as visible as the air program. In the early stages of the water pollution control program, emphasis was on data development. However, as the program moved from a study posture to a control posture, communities and industries initiated the construction of wastewater treatment facilities. This construction program created ever increasing amounts of sludges. The majority of these sludges are going onto the land. This practice until recently did not offer any major challenge to the solid waste management field. It does today, however, and we will review this challenge in more detail later in this paper.

This rather extensive background seems necessary in order to develop a rather broad understanding of the role of solid waste management in the fabric of our urban society. It is necessary to understand the evolution of solid waste management up until the decade of the 60's. The reasons are fairly simple. Until the decade of the 60's very little attention was paid to solid waste management as a part of the environmental movement. In addition, there was little or no concerted national focus. Further, the people working in the field were only minimally successful gaining the support they needed to get the job done. These reasons and problems have not gone away. However, there is considerable attention now being paid to solid waste management and the field is in far better position to address the challenges of the 80's than they were the challenges of the previous decades. One major problem is not being addressed fully, however, and that is to provide the needed talents. This absence may do more to prevent a successful response by the solid waste management profession than any one single factor.

Public Health Service Role

The federal government is frequently maligned for what it does. In the instance of the solid waste management field, however, the entrance of the federal government was for the most part highly productive and supportive. Most federal programs depend for the most part on specific legislation to rationalize and justify their activities. This is particularly true in the field of environmental protection. Most of the environmental programs began, however, without specific legislation. The U.S. Public Health Service (PHS) was the birthing place for today's federal environmental programs.

Utilizing the PHS Act, a limited number of sanitary engineering and sanitarian officers of the U.S. PHS Commissioned Corps led the development of the federal water pollution, air pollution, solid waste management and water supply programs.

In the 50's and early 60's the PHS invested a limited amount of federal investment into the problems of solid waste management. One of the earliest efforts was directed at developing training programs. In response to the problems of incineration and open burning, emphasis was placed on assistance to state and local government in improving disposal practices and implementing true sanitary landfill facilities. This effort was a low investment effort by the PHS, probably less than 6 fulltime people. In addition, this small program also invested a limited amount of federal funds for basic research and development with emphasis on identifying some of the basic operational aspects of disposal. In other words this small effort was directed at the beginning of a data base from which improved technologies and practices could begin.

American Public Works Association

The other significant effort directed at solid waste management training at that time was the effort of the American Public Works Association (APWA). The APWA was providing reference materials and information in the field. APWA published two references which remain today as basic documents for solid waste management — "Refuse Collection Practices" and "Municipal Refuse Disposal".⁴ In addition, APWA was very much involved with the efforts of the PHS solid waste program and did offer a limited amount of training and education.

Solid Waste Disposal Act

In October 1965, Congress enacted the Solid Waste Disposal Act.⁵ The passage of this act was the direct result of the efforts of this small cadre of PHS solid waste people and the APWA. This act was directed at what was considered the most deficient needs of the field: development of improved technologies; assistance in the development of state solid waste management programs; and the development of manpower for the field.

Consider the following:

1. At the time of the passage of the Act there was less than \$250,000 being invested annually in solid waste R & D.
2. At the time of the passage of the Act there were less than 10 full time state employees working in solid waste.
3. There were less than 2 full time people working in the

training and development of solid waste personnel.

The manpower and training efforts initiated with the authorities of this new piece of federal legislation were composed of a number of program activities:

1. Universities were provided training grants to develop graduate level engineering programs. These programs were to develop master's level personnel with specific training in the field of solid waste management.
2. Universities were provided research grants by which graduate students could conduct basic and applied research in the field of solid waste.
3. A direct training program already in operation in the PHS was greatly expanded. This program was to develop and offer short courses in the various aspects of solid waste management with emphasis on the operational aspects and directed at state and local government personnel with responsibilities for operating programs.
4. A technical assistance program directed at assisting state and local government with operational problems and to develop "hands-on" solutions to operational problems was initiated.

In the 60's the major operational aspects of solid waste management were collection and disposal. In fact, as a result of the air program incineration was, as mentioned earlier, on the decrease. Consequently, the demands for trained persons for solid waste management were for the most part in only two areas—collection and disposal. Efforts, therefore, by this new federal program emphasized research and development, training and technical assistance directed at these two areas.

By the end of the 60's, the federal program had invested over \$40 million in research, development and demonstration. Well over 60% of this investment was directed at disposal. The technical assistance efforts focused primarily on the problems of collection. Considerable basic information of collection management techniques were developed. The direct training program was actually presenting the following training courses:

1. Elements of Solid Waste Management—A short course directed at the solid waste systems manager which reviewed the best practices in the field.
2. Sanitary Landfill Principles—A short course directed at the sanitary landfill manager with operational aspects emphasized.
3. Collection Principles—A short course directed at the collection systems manager with operational aspects emphasized.
4. Incineration Principles—A short course directed at the incinerator manager with operational aspects emphasized.
5. Composting Principles—A short course which reviewed the

technology and application of composting.

In addition, some 12 universities were engaged in offering advanced degrees in sanitary engineering with a specialty in solid waste management. Finally, most states were receiving financial assistance to develop state plans and some 200 full time state employees were engaged in these activities.

Clearly, the federal program was attempting to train the managers and supervisors in the solid waste management field. Little or no effort was directed at the labor force of the field however. The federal training program was initiated with the concept that if the manager knew what to do and how to do it right that this would be passed down to the work force. However, the federal program saw the need for training tools for the manager and augmented the manager level training effort with several operational training packages that the manager could use to develop training programs for the operational work force. Two packages were developed, one directed at collection⁴ and one directed at sanitary landfill operations.⁷

These two programs were developed with films and slide materials to allow the manager to train his staff on-site.

Clearly, the combined training programs directed at both the managerial and operational level in the field of solid waste collection and disposal were responding to the needs of the field in the late 60's and early 70's as those needs were understood.

It would seem, therefore, that if these programs had been continued they might have provided the training needed in the field of solid waste management. However, if there is only one truism in our society it would be that nothing remains static and that we live in a dynamic world. The same can be said for solid waste management. Two major initiatives occurred in the early 70's that dramatically altered the federal program's efforts in training.

Resource Recovery Act

The first major development was a series of amendments to the Solid Waste Disposal Act.⁸ These amendments, referred to as the Resource Recovery Act (RCRA), were actually directed at two yet untapped and not understood aspects of solid waste management—resource recovery and hazardous wastes. The Resource Recovery Act called for the federal program to initiate a number of demonstration efforts to advance the technology of resource recovery. These amendments thrust the federal program out of the somewhat low technology field of sanitary landfill into the world of high technology. Certainly, the addition of higher technological approaches offered expanded opportunities for training activities.

The hazardous waste provisions of the Resource Recovery Act required the federal program to study and determine exactly what

should be done about this yet unknown and not understood in light of the Love Canals of today. Truly, this provision of the Resource Recovery Act has resulted in a dramatic awakening by the U.S. of at least one aspect of solid waste management. Earlier we discussed the development of wastewater treatment facilities in the U.S. This environmental protection development more than any other has brought about the increased amounts of sludges and other industrial wastes which represent the majority of the hazardous wastes today. Again, the hazardous waste provisions of RRA have created new demands for people which in turn has created new training opportunity needs.

The Resource Recovery Act also included a requirement for a study to actually determine the manpower that would be needed to respond to the future demands of solid waste management. This study resulted in a report however which indicated that there was actually no real need for the development of additional people to work in the field.⁹ Rather, the report somewhat naively concluded that the availability of unskilled manpower to work in the collection work force was so great that there was no real need for a training program for that portion of the solid waste workforce; that the needs for other personnel at upper levels did not appear to be great enough to warrant a training program; and that while personnel for state programs was critical, a training program for state personnel was not warranted. It might be added that the results of this report were highly controversial within the federal program and never fully supported by many working in the field. Nevertheless, while the report was never published, it served to shape the future of training in the federal solid waste management program for a number of years.

While the Resource Recovery Act added new dimensions to the field of solid waste management, efforts were under way to reduce the role of the federal government in solid waste management. In 1973 and 1974 the federal solid waste management program underwent severe budget cuts and the remaining resources were directed toward the development of a federal hazardous waste regulatory program. The efforts that were eliminated included almost all of the work in collection and other municipal solid waste management activities and the entire direct manpower training and development program.

Non-Federal Training Programs

By 1975 all federal support to universities to develop graduate programs in solid waste management were essentially gone. In addition, the short course training programs were also eliminated. The federal program attempted to counter these losses in other

ways. The most pronounced efforts are in existence today in many organizations which represent various interest groups in solid waste management. These interest groups are being funded by EPA to train people working in the field. These efforts include:

1. American Public Health Association — Program is directed at developing an understanding of solid waste management issues in public health personnel.
2. National Association of Counties — Program is directed at rural solid waste management problems.
3. Conference of Mayors — Program is directed at advancing community resource recovery efforts.
4. International City Management Association — Program is directed at assisting in the implementation of municipal solid management systems.
5. Association of State and Territorial Solid Waste Management Officials — Program is directed at providing a means for state officials to meet to improve state programs.
6. American Public Works Association — Program is directed at improving disposal operations.
7. Governmental Refuse Collection and Disposal Association — Program is directed at improving disposal, resource recovery, and hazardous waste operations and practices.

In almost all instances, these projects also include information dissemination efforts and technical assistance through the "Peer Match" mechanism. However, none of the above mentioned programs are part of a comprehensive national plan to develop and provide the human resources needed to respond to the solid waste management systems of the future.

In 1976, additional amendments to the original 1965 Solid Waste Disposal Act, the Resource Conservation and Recovery Act (RCRA) added yet another dimension to the solid waste management field—a national commitment to regulate hazardous wastes management and disposal.¹⁰ This commitment has brought the entire solid waste management field into the limelight of public attention. While the focus is on hazardous waste, the entire field is being swept along with the public demand for more technological and institutional advances than ever before conceived.

The solid waste management programs under implementation today represent the most dramatic and dynamic effort ever advanced for the protection of our environment, the preservation of our national resources, and the protection of the public health. Consider where we have come in 15 short years. In 1965 our perception of needs focused on the problems of collection and disposal.

These two problems remain as the cornerstone of today's national efforts in solid waste management. But, we have added so many nuances to those two aspects that today they are almost entirely new fields of endeavor.

New Challenges

In addition, the field is faced with a number of new challenges and demands. Resource recovery today is no longer the rag picker or the hog feeder. Technologies are being developed today to take our wastes and provide an energy source to help respond to this most critical national need.

Hazardous waste management brings into the field a more sophisticated management approach than ever considered in 1965. The national investment to manage these wastes from the original point of generation through all steps of the management cycle is the most ambitious environmental effort undertaken by our country. The technologies that will have to be developed and provided to respond to this commitment will be some of the most sophisticated of any ever used in the field of environmental protection.

In 1961 our major concern was to stop the open burning dump. Today, we look upon a solid waste disposal facility as a technology that must be designed and operated with sophisticated equipment and trained manpower. The need to protect surface and groundwater from the leachates of such facilities is far better understood today. This understanding calls for equipment, systems and technologies that were not even available in 1965.

The collection industry in the past 15 years has moved from one of multiman trucks to fewer trucks, fewer people and more automation. Containerized services for commercial and industrial collection services have just about replaced the inefficient small storage container. Perhaps the most dramatic advance is yet to come in the application of automated one man collection vehicles to collect residential and commercial solid wastes. This technology may have implementation difficulties in the East, but its presence will foster advanced collection approaches in our crowded Eastern urban centers.

These advances and challenges of the 80's will require people. Those people, however, will have to be far better trained and skilled than our systems demanded 20 years ago. We do not, however, have a national manpower development program to respond to the need. Our most critical problem today is the lack of a national forum which can serve as a means for the field to get together to determine our needs and develop a strategy to meet those needs.

The order and magnitude of need is not known. Further, the current universe of people working in the field is unknown. The

January 81 EPA Journal included information on environmental manpower numbers.¹¹ A report by the National Academy of Sciences referenced in that journal indicates that there were some 275,000 solid waste workers. This data from a 1977 report is probably close to 7 years old and cannot be considered representative of the workforce of solid waste management in the 80's. The EPA Journal also listed the emerging occupations in solid waste management and focused entirely on the job demands resulting from the implementation of RCRA's hazardous waste and disposal regulations. No mention was made regarding the need for manpower in collection. The journal goes on to provide a laundry list of training available including short course direct training and academic training. Solid waste management training opportunities are not included on that laundry list because none exist.

Opportunities

The opportunities in solid waste management in the future appear to be unlimited. The personnel for the jobs that will be available will come from other disciplines. These people for the most part will have to learn their job by on-the-job training. They will not be able to go to training centers and get the necessary background. Moreover, they will have a difficult time finding literature to help them in learning their jobs. In certain areas of the field, particularly collection, the literature is very limited and outdated. EPA is developing a number of manuals and handbooks to help implement RCRA. These materials, for the most part, are directed at hazardous waste management only.

At the present time people moving into management roles will be able to gain a certain amount of knowledge by attending conferences and seminars which are offered by associations and private training organizations. The conferences and seminars of the associations do offer an excellent opportunity for people to get acquainted with other people in the field. Costs to attend such meetings though is not small and the number of people who can attend is limited.

An essential need, therefore, is a regionalization of training which can provide to the people at the local level an opportunity to learn the business without having to travel far or pay high registration fees. It would seem that state solid waste agencies should be the sources of such training. State programs might be able to use some portion of funds received from EPA to offer training. However, they have not been encouraged to do so by the EPA.

National Strategy Needed

This lack of encouragement stems a great deal from the lack of national strategy and plan for the development of solid waste

management manpower. Certainly, EPA in cooperation with the various organizations should develop such a strategy and define a plan for how the strategy should be implemented.

The strategy needs to take a close look at what are the relative roles of various organizations in providing people for the field. The strategy has to assess the various efforts under way today including based upon skills required and future career opportunities. The strategy has to assess the various efforts underway today including EPA's internal efforts and their support to various organizations and associations. Finally, from these analyses, the strategy should chart a course of action which would serve as the basis for training of people as well as how such training efforts should be provided and funded.

The strategy would serve to guide federal, state and local government in their support of training. EPA could use its funding to serve as a catalyst to stimulate implementation of the strategy. Organizations in the field could utilize the strategy to plan programs to provide the talent needed for solid waste management. Many of the organizations have developed and do have available a limited number and variety of training courses. More could be developed with a limited investment on the part of the EPA, State government and others.

The fact remains, however, that training programs will not be developed without a strategy and someone exercising national leadership. No one argues for a large federal program in developing people for the solid waste management field. However, it seems clear that the Federal government must serve as a catalyst.

The types of training from a generic sense appear to be fairly obvious:

- Operational skills in residential, commercial and industrial collection
 - Management skills to plan, organize and manage collections systems
 - Improved operational skills in disposal facility operation
 - The development of skills to operate leachate and landfill gas collection, treatment and utilization facilities.
 - Improved skills in the siting and design of disposal, treatment and resource recovery facilities.
 - Monitoring and surveillance techniques for solid waste and hazardous waste facilities
 - Operational skills for hazardous waste handling, transportation and management facilities.
 - Operational skills for resource recovery facilities
 - Management skills to plan and implement regulatory programs
- This list is endless and offers a real challenge to those who are

involved in developing people for the solid waste management field. What remains is a means for the field to respond to their own needs. That means is not available today.

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Perspective on Air Pollution Training

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INTRODUCTION

Perspective on training for the 80's involves, of course, a view on the relationship and importance of training to achievement of air quality for the nation, but it should also identify the point of view from which the perspective arises. Experience with training in EPA may illustrate the difference between training as it theoretically could be and the way it is, let us say the logical and nonlogical. Logical involves the considerations resident in the theory of organization operation as reflected by teaching from schools of business and public administration; nonlogical is real life, the way things are in both business and government.

Thus this presentation is in two parts. First we will deal with actual facts of training program form and outputs and next with judgments of training program need, based on the theory just mentioned, that have been expressed in major studies released in 1977 and since, including the just published report of the National Commission on Air Quality. These studies will suggest the type program that "should be" in the 1980's.

In part two although we turn to what has been termed the nonlogical we will not depart from facts but will provide some historical background on EPA training program operations as a possible indicator of the future. From this you can make your own forecast on the likely shape of air pollution training for the 80's. In closing I will mention the key features of EPA's air pollution training program as it "will be" given a continuation of current constraints.

Training Objective

Most rational activity begins with an objective. The basic objective of EPA's air pollution training program is to assist nonfederal regulatory agencies in the acquisition of skills needed for effective conduct of air pollution abatement programs. EPA has addressed this objective since its beginning as an organization, initially under authority of the 1967 amendments to the Clean Air Act, which recognized "that availability of trained manpower at the state and local level would be a precondition for effective and responsive state and local action."

Thus EPA's air pollution training began with programs to increase the amount and quality of the nation's air pollution training output both academic and direct and included student support money to stimulate enrollment into air pollution abatement academic programs. Program benefits have, of course, not been limited to government regulators. EPA's investment in air pollution training has built a workforce increasing the level of competence on both the enforcement and the compliance side of the air pollution abatement process, and to the extent that support is channeled through higher education our training support has contributed to the maintenance of training programs needed as a national manpower development resource. The current program emphasizes direct training output for agency needs with no funds earmarked for curriculum enrichment or other type of institutional support for higher education.

Overview of Program

Now let me give a brief overview of what our air pollution training program provides. EPA's training program can be divided into two areas, academic training and direct training. Academic training includes those activities that are conducted by institutions of higher education designated as Area Training Centers, principally involving delivery of air pollution instruction under established curriculum, the provision of traineeship support from EPA for a small number of students, and the conduct of noncredit intensive instruction (short courses) in response to training needs as indicated by air pollution control agencies in the Center area. In short course instruction Area Training Centers use course materials including lesson plans provided by EPA.

Direct training in general includes the activities conducted by the Air Pollution Training Institute which is operated

under contract by Northrop Services, Inc. The work principally involves short course instruction, the development of course materials including self-instructional courses, and the delivery of short courses. Other activity includes conduct of workshops, preparation of video-cassette learning units, technical assistance to universities and state/local agencies and the administrative/logistic support for Area Training Center short courses, i.e., admissions processing, printing of student manuals, attendance records, etc.

Program Funding

Money for air pollution training comes under the broad classification of Abatement and Control and under a sub-classification of Programs Resource Assistance (SPRA). The estimated amount of direct training money for FY-'81 is \$1,010,000 and of academic training money is \$320,000. Direct training is conducted under a contract with Northrop Services as mentioned earlier; academic training is conducted with training grants to the Area Training Centers. Both types of training are "forward funded" i.e., grants made and contracts let with FY-'81 money pay for activity conducted in FY-'82. To further illustrate we will make grant awards in the next two months (FY-'81 money) to our Area Training Centers. These awards will pay for activity in the academic year October, 1981 through September, 1982. Although in comparison with other governmental programs \$320,000 is a very small academic training investment it does keep the program alive for another year.

Studies

Let us now turn to some judgments on air pollution workforce and training with brief comment on significant environmental manpower studies that have been released over the past four years. The earliest major study was released in 1977, is titled "Manpower for Environmental Pollution Control," and was conducted under contract between EPA and the National Academy of Sciences by the direction of the Congress in EPA's appropriations for FY-'74. Chairman of the study committee was Earnest F. Gloyna, Dean of the School of Engineering, University of Texas, Austin, who gave the opening address for this conference. You could spend all day discussing this important report prepared with the guidance of 15 members of the Academy's Committee for Study of Environmental Manpower and with input from five panels. I'll mention only three things. The Committee noted it is apparent

that the quality of the current environmental workforce could be upgraded through supplemental training and improvements in the educational process, noted EPA's responsibility for a leadership role in environmental management development and called for EPA establishment of a well coordinated federal manpower planning and training program for environmental control mandated by congressional and executive action.

The next study that should be mentioned was large and was also prepared in response to a congressional call made in 1975, two years after the earlier call for the National Academy project. The study, A National Environmental/Energy Workforce Assessment, had as its objective "to provide EPA with the information necessary to formulation of a rationale for initiating and supporting national education and training programs." The study was financed by congressional add-ons to EPA's appropriation item academic training beginning with the FY-'76 appropriation and was conducted by the National Field Research Center, Inc. under Training Grant T900591 covering three years and with a total cost of \$1,268,000.

For this report I will mention only one aspect. The section on Salaries and Attendant Problems of Public Sector Environmental Employment notes the fact of environmental agency salary levels demonstrably well below the average for the professionals fields involved and concludes that employee turnover is a perennial problem of major proportion and a significant impediment to the achievement and maintenance of an acceptable performance level within affected agencies. Incidentally the note on salaries repeats similar findings in the report, Manpower and Training Needs for Air Pollution Control issued in 1972 by the Secretary of HEW and the same judgment in panel input to the NAS report earlier referred to.

The next report that should be mentioned was prepared by the Urban Systems Research and Engineering, Inc., Cambridge, Massachusetts, subject: Analysis of EPA Technical Assistance to State and Local Governments with a volume on air program training needs. The report has just recently been finalized and Michael Alford who is a speaker on this panel played a major role in its development.

The next report parallels the one just mentioned. It is dated December 1980, subject: An Institutional Assessment of the Implementation and Enforcement of the Clean Air Act, and was prepared by the Urban Systems organization just mentioned for the National Commission on Air Quality. The report

develops conclusions from five separate in-depth case studies of operating air pollution control programs in five areas of the country.

In dealing with capabilities of the agencies to perform their responsibilities under the act the report mentions that staff turnover is high, training is limited, and pay scales are low, all familiar themes.

In listing reports one should not omit a July, 1980 document prepared by the American Association of Environmental Engineers, subject: An analysis of the Role of the U.S. Environmental Protection Agency in the development of Manpower for Water Pollution Control which was the subject of a presentation to this conference by Dr. Bruce Hanes in the session on water pollution. This is, of course, an air pollution session but I commend Dr. Hanes' report to you for insight on the philosophy that has essentially governed EPA actions on manpower development including air pollution workforce.

And now last mention of a report, the important and yet to be officially released report to the Congress of the National Commission on Air Quality, prepared in accord with the 1977 amendments to the Clean Air Act. The preliminary staff draft of this report validates and incorporates the findings of high turnover and low salaries in air pollution control agencies that have been recorded in the earlier studies we have just reviewed. The draft of the report does not contain recommendations, it contains options which are considered by the Commission in final establishment of recommendations.

Forecasting

I would like now to turn to material which can help in forecasting the probable shape of things to come. First, let's restate the basic rationale for training.

As an organizational function training is not necessary for effective operation of the organization. If one can pay high enough salaries one can recruit people who are trained already, perhaps in other organizations. The basic problem for those who administer salaries and wages is to set those payments at an optimum level. At what level must salaries be to avoid the costs of excessive turnover, which include costs of training, of low productivity, and costs of mistakes by the inadequately qualified worker. Most organizations, of course, find that the approach with optimum return involves a blend of reasonably competitive salary structure and reasonable investment in

training. The problem with air pollution agencies is that in general salaries are not competitive and that agency directors do not have authority to make the adjustment that would generate competitive levels.

Let me provide a quote that indicates a full understanding of what I have just said:

"A high turnover rate, of course, whether it is in business or government, usually is enormously inefficient because, as we all know, it often takes a new person months and sometimes even longer to learn a job.

And the lower your turnover rate, the more efficient your operation is likely to be."

Where salaries are not flexible and where one wants efficient operation it would seem necessary to offset some of the effects of turnover with investment in training. Incidentally the quote just provided comes from Senator Proxmire on March 10, 1978 as he conducted Hearings on EPA's FY-79 appropriations which did include money for training above a zero request from the Administration.

At this point let us accept without introduction of new data the conclusions about low relative salaries and high relative turnover in air pollution control agencies that are reflected in the studies mentioned earlier. And let us assume that the National Commission on Air Quality will recommend an increase in federal support for air pollution training programs. What is the likelihood that the trends of the 70's will be reversed in the 80's? Let us look at the 70's.

We have a national air pollution workforce of about 7,600, and it seems reasonable to project no increase or slight reduction in these figures in the 1980's. Public sentiment on regulation seems likely to prevail long enough to limit growth in the regulatory workforce for at least the next four years. Trends can be confirmed by comparing Agency workforce levels as reported in APCA's annual Directory of Governmental Air Pollution Control Agencies. Thus whatever the training problems in the 1980's it does not appear that expansion of workforce will be one of them.

The trend in financial support for training in the 70's differs significantly from the trend in the workforce level. The trend has been significantly down from the beginning. The Association of Local Air Pollution Control Officials believes the downtrend has been too steep and have so stated in a December 20, 1980 letter to the National Commission on Air Quality. The Association believes that EPA should recognize

the importance of its educational role by stepping up its activity in this area and calls for manpower training services to receive increased funding. In particular the Association calls for an expansion of special purpose workshops.

Figures covering academic training indicate an even more precipitous decline in training activity in part because the decline was from a higher level in 1971. Investment in that year was high, but then we were building a program of instruction that had been nonexistent, and we were training individuals for a workforce that approximately doubled between 1971 and 1975.

Other Support Programs

I would not like to leave this data without some comment on air pollution training investment as compared with other federal support programs as for example in health services.

HEW established occupational health area training centers about the same time we did, but in FY-78 the occupational health program had \$7 million in training appropriations. Nursing education in the same year received \$47 million but the most massive program of all is the scholarship program of the National Health Service Corps, which seeks to place health service professionals into health manpower shortage areas of the United States. The FY-81 appropriation was \$79.5 million; Mr. Reagan's recommendation for the FY-82 appropriation is \$63.5 million. In 1979-80 7.6 percent of all medical students in the United States drew financial support from the National Health Service Corps scholarship program, which has one similarity to our own traineeship program: support is conditional. Our trainees receive loan forgiveness for working in a governmental job, NSHC scholars must repay three times the support received if they do not work for a prescribed time in the health manpower shortage area.

The Future?

Considering the trends, what can we anticipate? For example, we are offering only 28 short courses in eight subjects compared with 74 and 19. These 28 courses will be conducted by Area Training Centers and partially supported with money from the academic training appropriation. Let me remind you that academic training money has absorbed for three years a part of training activity that historically has been paid for with money from the direct training allowance. If there is no academic training money in this year's appropriation the future of short course offerings by EPA may be dim. And, of

course, with no academic training money support for university training will finally be phased out.

The direct training appropriation is projected to continue but at a fixed level of close to \$1 million. Contractor costs between FY-80 and FY-81 are estimated to have increased by 20 percent, and MTIB overhead costs including EPA staff salaries, supplies, travel, etc. have also increased and must be paid for from the fixed sum of \$1 million. It is, of course, obvious that activity must be reduced as money available is diminished.

I have earlier mentioned that the Northrop Services contract ends this year. A request for proposal to continue the contract has not been released but it is obvious that the reduced money available for the contract will mean a curtailment in the scope of work to focus on preparation and maintenance of training materials that can be made available to air pollution agencies, to universities and to anyone who has need for development of skills in air pollution control science.

The central problem is lack of resources for conduct of the training function. Are there any alternative sources for support of training? In many cases the answer is yes depending upon how strongly felt is the need for training. Much training gets done in the environmental field that is paid for with money not coming from a training allowance, and training activity occurs which is not conducted under conventional training terminology. There is essentially little difference in the learning outcome of intensive attention over a few days to newly issued regulatory guidelines or to a technical topic whether it be called short course or workshop, but money may be easier to get for a "workshop" than for a "training course."

We need to emphasize again the strong need for training and the willingness of many to give it the priority it deserves. In Region IV state and local agencies came to the Regional Office requesting assistance with training. They had a strong need but no money to pay for the travel cost of attending EPA courses. The Region came up with a unique approach; they found money and channelled it through our Area Training Center at the University of Florida with a training grant that pays travel costs for selected agency personnel attendance at EPA courses. Within the last several months word has come that Region V is considering the same approach to assist Ohio environmental agency personnel.

The need for training is permanent. Neglect in maintenance on a transportation system can be tolerated for a while, but if

the system is to operate, a certain level of maintenance investment is required. Training is a cost of doing business, and if environmental programs continue, the need for training will ultimately exert sufficient pressure to warrant investment in air pollution training above the levels we project for the next two years.

Summary

In closing let me acknowledge that in this brief paper I have included no perspective on the quality of EPA training and actions that are taken to insure that training is relevant and can be delivered efficiently. That is a separate topic.

I have given you a brief overview of our training program content; I have briefly mentioned judgments of and recommendations for EPA air pollution training programs that have been made by various authoritative study groups; and I have provided you with factual information on what has happened in the last ten years in the real world of air pollution training funding. I leave a certain amount of forecasting the future to you, but I do offer the thought that a large number of talented people have worked hard to generate public awareness of the problems that abatement programs must solve to achieve air quality for the nation. Input to the work of the National Commission on Air Quality is only the most recent example, but it does illustrate that the role of training has been put in an appropriate context, and I am optimistic that the Committee's report will be an important and a constructive influence in achieving the support for training that is warranted.

Manpower Requirements and Training to Control Air Pollution

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INTRODUCTION

I would like to mention some of the fields of education and training that are used in the air pollution control field. Figure 1 lists most of the kinds of people engaged in air pollution control. Conspicuous by their absence are the attorneys, politicians, and others associated with the regulatory development process. These people are used by all levels of government, industry (both the users and the manufacturers of abatement and measurement devices), academia, consulting, and environmental groups. Depending upon the size of the employer or the specific areas in which they wish to involve themselves, all or any combination of disciplines may be found within an organization. To get a better idea of where people can be employed in the field of air pollution control and what kinds of duties they perform, the Journal of the Air Pollution Control Association in 1979 began publishing career opportunities. This is continuing and to date 6 different areas have been described in depth. I will discuss some of the great variety of work a little later.

Manpower Needs

It would be helpful to give you hard and fast numbers of people in the field of air pollution control as well as projections of those who will be needed in the future. Unfortunately, I cannot because as I delved further into background data for this paper I realized that, as in many other areas, there is little new material available. Data from many years back is repeated by most writers with no new infusions. Therefore, I made up some new figures which have a smattering of facts so they will be difficult to dispute. In 1976 there were estimated to be

EDUCATION DISCIPLINES USED IN AIR POLLUTION CONTROL

CHEMICAL ENGINEERS	COMPUTER SPECIALISTS
MECHANICAL ENGINEERS	STATISTICIANS
ELECTRICAL ENGINEERS	RADIOLOGISTS
CIVIL ENGINEERS	PHYSICISTS
SAFETY ENGINEERS	CHEMISTS
SANITARY ENGINEERS	RADIO CHEMISTS
ACCOUSTICAL ENGINEERS	METEOROLOGISTS
MEDICAL DOCTORS	ENGINEERING TECHNICIANS
VETERINARY DOCTORS	ELECTRONIC TECHNICIANS
OPTOMETRISTS	PHYSICAL SCIENCE TECHNICIANS
PSYCHOLOGISTS	
NURSES	
PHARMACOLOGISTS	
PLANT PATHOLOGISTS	
LIMNOLOGISTS	
HYDROLOGISTS	
GEOLOGISTS	
BIOLOGISTS	
AQUATIC BIOLOGISTS	
MICROBIOLOGISTS	
ENTOMOLOGISTS	
LAND USE AND URBAN PLANNERS	

Figure 1

about 7300 people in the non-Federal governmental air pollution work force. In 1974 there were 5400 workers in this area with another 11,000 in other State and local government agencies indirectly concerned with air pollution. The lower figures are those who work for air pollution control agencies while the others are in planning, transportation and other agencies which either impact or are impacted upon by air pollution. In the Federal government there are at least as many professionals dealing directly with air pollution problems as are in State and local government. In industry, the number of air pollution professionals jumped from 10,750 in 1969 to over 22,000 in 1974. If

one were to count maintenance workers, technicians, construction workers, etc., in the private sector also involved, the number would be well over 100,000—a not inconsiderable work force. The Air Pollution Control Association—a society dealing with only air pollution and all its ramifications—has over 7500 members. This is only a small percentage of people in the field as many organizations may support one or two of their staff as society members and others none at all. As an example, a group I worked for who were all directly involved in air pollution control numbered over 30 but only 5 were APCA members.

When we talk about the need for people in air pollution control, I think we should keep in mind that as long as I have been in the field there have been the doomsayers predicting shortages of qualified professionals, and yet, that prediction never seems to come true. People in air pollution control play musical chairs. The same names pop up in industry one year, government the next and consulting the third. They go where the job market is. In this job market, at least, the law of supply and demand works admirably.

I am certain most of you know the type of work that is performed when controlling air pollution but I would like to mention some of the backgrounds in order to show the tremendous variety. Probably the largest number come from the engineers—chemical, electrical, environmental, civil and mechanical—because they are so versatile. They are qualified to evaluate the technical aspects of legislation, to enforce regulations through equipment inspection, and to design and install control devices. Biologists, plant pathologists, limnologists, hydrologists, and chemists work primarily, but not only, in the effects area—what air pollution does to plants, animals, and structures and how the deleterious effects can be lessened. Physicians and others associated with the medical field usually conduct research on the relation between air pollution and human health. Atmospheric chemists, meteorologists, physicists, all work with the transport of air pollution from one area to another and the chemical changes it undergoes in its travels. Attorneys, political scientists, economists, and planners all work in the legislative and social science area. There is probably no technical or professional background not required somewhere in air pollution control.

The figures cited before give an idea of where these people are mainly employed—government, industry, consulting, and academia—but the variety within these major groups needs a little more illustration. When you think of a government air pollution worker, do you think of the engineer going out in field to inspect a contaminant source or control device or do you see a senate staffer working with his house counterpart to reach a compromise on a bill coming before the Congress? When looking at academia, do you see the professor teaching a course in environmental management or the

researcher finding evidence of pollution-induced disease where it was never found before? The possibilities are virtually limitless.

The figures I quoted before show over 100,000 people in the field but they do not include those who rise into management and, consequently, leave the technical area nor those who do not practice air pollution control. The number of 100,000 is extremely fluid and should be used only as a very rough approximation, especially when related to the number of graduates entering the environmental arena that I will talk about later. In addition, although one may graduate with an air pollution specialty, the job obtained may encompass air, noise, water, solid wastes, and anything else of employer interest. Those who graduate in other disciplines may work in air pollution. Thus, although the job market is expanded, so is the number competing for positions. There are no concrete figures for graduates in all disciplines (law, economics, etc.) entering the environmental work force nor those with environmental degrees who do not practice in the field. You can easily see the difficulty in obtaining such numbers.

Training

A little easier to determine are the numbers of schools which award environmental degrees and the number of graduates. But even here confusion arises because some schools award standard degrees in civil, sanitary, or general engineering while leaning heavily on environmental courses. When trying to separate those who specialize in air pollution, the situation becomes even more complex. I'd like to interject a comment at this point. We are talking today about air pollution manpower requirements and I think when we speak of training in a formal sense we cannot be parochial. Air pollution control, as most of you are aware, encompasses other environmental spheres such as water, solid waste, and hazardous material. Because of this, it is necessary for the air pollution expert to be just as familiar with these other areas and conversely, the other experts must have knowledge of air pollution control. It would be wrong to separate the air pollution expert from the rest of the field because this person will eventually branch out to work in the other disciplines.

Figure 2 shows the current trends toward environmental training in colleges and universities. From 1971 to 1978 both the number of schools granting environmental degrees as well as those granting standard degrees but including environmental courses increased. Even the community colleges were caught in the upswing. One controversial aspect is the increase in environmental bachelor degrees which some feel is wrong as they believe one should obtain a basic background and specialize at the graduate level. Nevertheless,

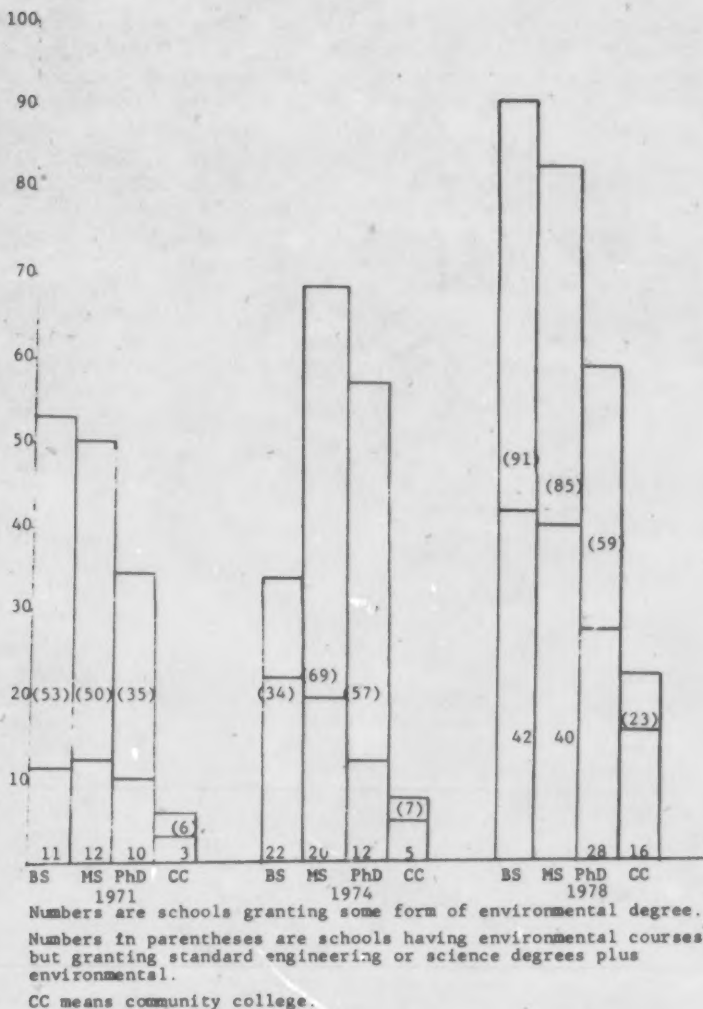


Figure 2

even with the decrease in grant support from EPA, the number of schools granting environmental degrees more than tripled from 1971 to 1978 and the total number of schools teaching some environmental courses almost doubled. I think we have to temper this data

by saying that the decade of the 70's could be called the environmental era. The EPA was formed, the Clean Air Act was strengthened, money poured into sewage treatment construction, and solid waste disposal began to come of age. That may be changing as I'll discuss later. From 1964 to 1968 there was a steady increase in environmental and sanitary engineering graduates—primarily in the MS degree. From 1968 to 1971 there was a small fluctuation in the number of degrees conferred but they held between 300 and 400. In 1972 there was a sharp rise—more than double in 1973 to a new plateau of around 800 per year. These trends are shown in Figures 3 and 4 from data compiled by the National Academy of Sciences. Additional figures indicate that since 1971 the number of students enrolled in environmental engineering and science has been declining and this would begin to show up in total graduates after 1975.

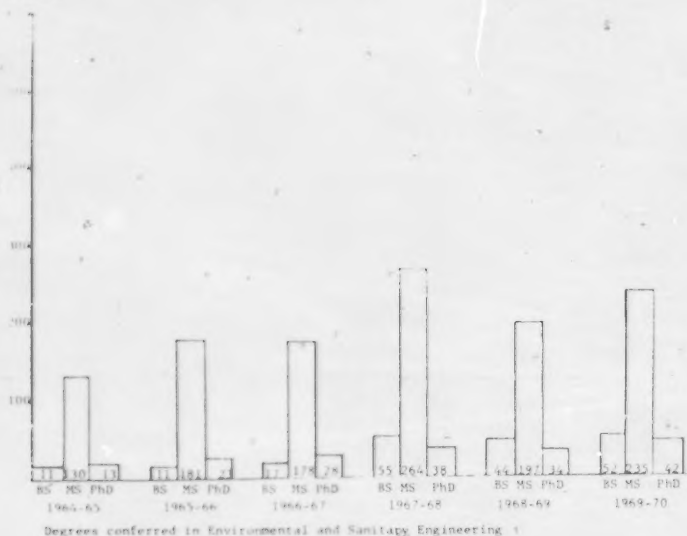
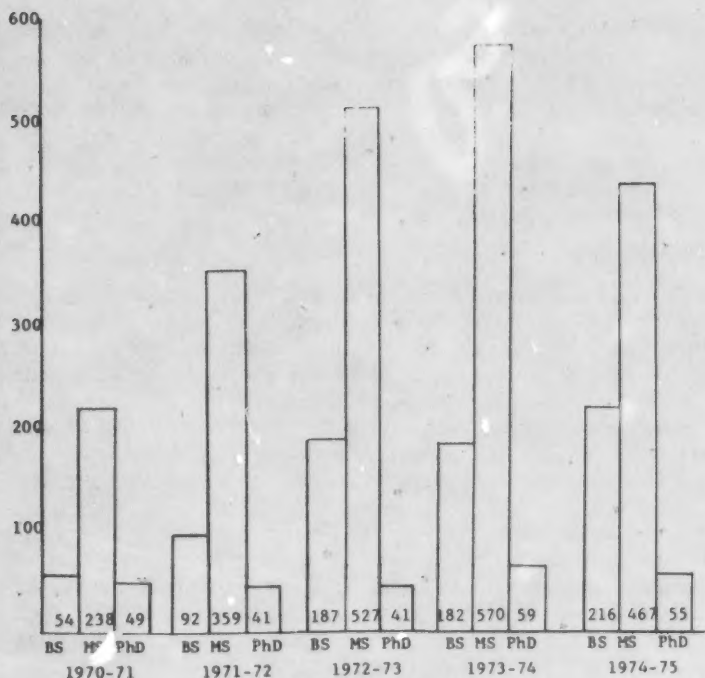


Figure 3

You may wonder how we can have over 100,000 in the field of air pollution or, if we consider only professionals, 50,000, when we graduate less than 1,000 a year and they don't all stay with air pollution. There must be some other source of training. That source is on-the-job. Most engineers and scientists take basic courses of traditional study regardless of their field of practice. When they go to work, they begin their specialization training. Environmental



Degrees conferred in Environmental and Sanitary Engineering.

Figure 4

professionals are no different. If the new graduate has had some environmental course work, it may dictate his future professional interest but even those who have not been so exposed may find themselves working in the ecological area. Many of these, in order to expand their knowledge, take night graduate programs, courses not leading to a degree, or continuing education classes. The latter two groups do not show up in the educational statistics I have been quoting but they do produce practitioners in the field who vastly outnumber the former. The kind of on-the-job training which is available varies generally with the size of the company. The larger it is, the more likely specialization becomes. The engineer in the small operation will probably be a jack-of-all environmental trades. This is not necessarily bad because of the interaction between the different environmental areas. Air pollution solutions may result in water and solid waste contamination which must be treated. Obviously the large industries will have more people involved with their emission

and waste problems and these people will specialize. The same tends to be true for control agencies—the larger they are the more specialization—which can go to extremes such that certain engineers work on metallurgical processes while others are involved with incinerators. In general, I would venture to say that most of the professionals in the air pollution control field today have obtained the bulk of their experience and training on the job and the minority have environmental degrees.

Technicians

One area not covered so far but where a serious shortage occurs is with the technician. What is a technician in air pollution? He is the nuts and bolts guy. He may be called electronic, mechanical, or engineering technician but he is the one who keeps the equipment running whether it is sophisticated air monitoring units or complex control devices. He will set up the meteorological towers and calibrate the ozone monitor as well as conduct the emission test.

Educationally, the technician gets short shrift. There are few formal programs for technician training although recently there have been efforts to develop certification programs. Everyone agrees it would be beneficial to have standard training programs to generate competent technicians. The rub is that generally the technician-to-be cannot afford the training to polish his skills in a specialty and after he goes to work in the field, his employer can't afford to spare him from his tasks. The technician then learns on the job or he attempts to take courses during slack time when they may not be available.

If there is any position that may be in short supply in environment, I believe it is the technician. Today, the swing is toward more sophisticated equipment and the need to have someone keep it functioning is critical. The monitor that tells you if you are emitting more than you are allowed has become part of your process equipment and you need it to tell you not only if you are in compliance but whether you are operating most efficiently. Obviously the engineer can perform the work of the technician but (1) he may not want to or (2) you may not be able to afford to have him do so. Also, if the engineer performs as a technician he will not do so for long because of the lack of challenge and other incentives. While the engineer can be a technician, the reverse is not true because in some realms such as compliance or regulatory interpretation the technician is not qualified. Unfortunately, I have no numbers to give you regarding technician demand but I believe a reasonable estimate would be one fifth to one quarter of the professionals or 10,000 to 15,000.

Future Needs

The question I raise now will probably not be a popular one if you are looking toward increased activities and needs in the environmental field. Is the bloom off the rose? You are all aware that the current administration—and incidentally, I guess I should state at this point that all of my comments relate strictly to the United States; the rest of the world is another ball game—has pledged itself to less government involvement with States and the private sector and, hence, less regulation. Assuming it is able to make strides in that direction, which is a big assumption, it would result in many regulatory agencies of the Federal Government going into more of an oversight role and turning regulatory operations over to the States. A reduced Federal work force would result but I do not believe a concomitant rise in State personnel could be expected. There are many reasons for this, not the least of which is the desire to reduce spending. I do not doubt that the job market for environmentalists with Uncle Sam for at least the next year will be sick. At the same time, because the pressure from the Federal sector may be reduced, there may be fewer openings in the nongovernment market. I think most of the reductions will come from attrition and reduced interest by people who were ready to enter the profession. There will be a domino effect felt by the schools as fewer students are attracted to curricula that have lost their potential—at least in their eyes. Loss of students has already begun, as we said before, probably as the result of decreased grant and student financial aid by EPA. After the decline in the emphasis for the environment will follow a rise and then the cycle will repeat. This will be caused partly by what is politically favorable at the time but also by a balancing between the environmentalists and the anti-environmentalists. It is unfortunate that this cyclic behavior occurs because we need people at all times who can realize the effects upon the environment which apparently unrelated activities may have. Someone who has knowledge of ecological impacts can have a moderating affect upon well intentioned but shortsighted actions. Courses in environmental awareness must be continued in institutions of higher education simply to make the future voters at least aware of the implications upon the environment that seemingly expedient moves could cause. I am a firm believer that a well informed populace is necessary for national well being and the informing begins with formal course work. It would be a shame if schools deleted these types of instruction due to lack of demand or financial support. Even when the enrollments in engineering or social science fall, the universities still offer these curricula and I believe no less should be expected for the environment. Maybe we don't need as many people working directly

in the environmental field over the next two or three years but we certainly need more of the general population with a greater awareness of the world they live in. Training the professional is very important because he gives us and utilizes the tools needed to solve the problems, but, as I think we are all aware, if you don't have the support of the people as a whole, you'll wind up pushing an unpopular view and you will accomplish little.

How do we go about creating this interest? I feel we must use the facilities that are already available—the schools. I don't only mean colleges and universities but also the high schools and elementaries. First, since financing is so important to aiding graduate students, we should encourage EPA to reinstate its training grants. Second, other funding sources should be sought such as corporations with progressive outlooks. Third, the Air Pollution Control Association should set up student chapters in every university that teaches the natural sciences so that students who have an interest can find out more about all the ramifications regarding pollution control. Speakers from industry, government, environmental organizations, and other groups can inform the students about the complex issues and stimulate discussion and dissent, but most of all thought. Fourth, we've got to tell our story to everyone who will listen and when I say our story I mean all sides. Industry, government, consultants, academia all should have speakers' bureaus to talk to children at the elementary and secondary levels, to appear before civic organizations, and to communicate with professional groups. Panel discussions on television and radio can draw large audiences—maybe not compared with Dallas—and can present the pros and cons on particular, timely issues. Whatever the media and method, the professionals in all the fields of environmental protection should should stop talking only to themselves.

Barry Commoner said there is no free lunch. If we foul up on something in the environment, we may be sorry and regret it but it is our children and grandchildren who will pay for it.

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State Training Needs For Air Pollution Control Programs

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"Little attention has been or is being given to long range environmental manpower planning."

"... those preparing Federal legislation in the environmental health field give little consideration to the associated manpower requirements. If a law causes an unusually heavy training or educational requirement within a given Federal agency, it is up to officials of that agency to present Congress with an outline of their needs. . ."

*Congressional commentary**

INTRODUCTION

The Clean Air Act, as amended most recently in 1977, places the burden of air pollution control and regulation jointly on Federal and state governments. Major Federal responsibilities include the development of health and welfare-related ambient air quality standards, and the specification of emissions performance standards for a wide variety of pollution sources, especially new industrial plants and motor vehicles.

The major activities performed by each state are: 1) to monitor air quality throughout the state; 2) to create, substantiate, defend, and revise the state implementation plans (SIPs);

*Quoted in Dade W. Moeller, "Continuing Education in Environmental Health," Harvard School of Public Health, Boston, 1979.

3) to grant and enforce permits to industrial sources of air pollution under Federal permitting regulations; and 4) to execute or oversee any other actions necessary under the SIP to bring states' air quality into line with national ambient air quality standards. These functional areas were the core around which we examined general technical assistance needs of state air pollution control agencies.

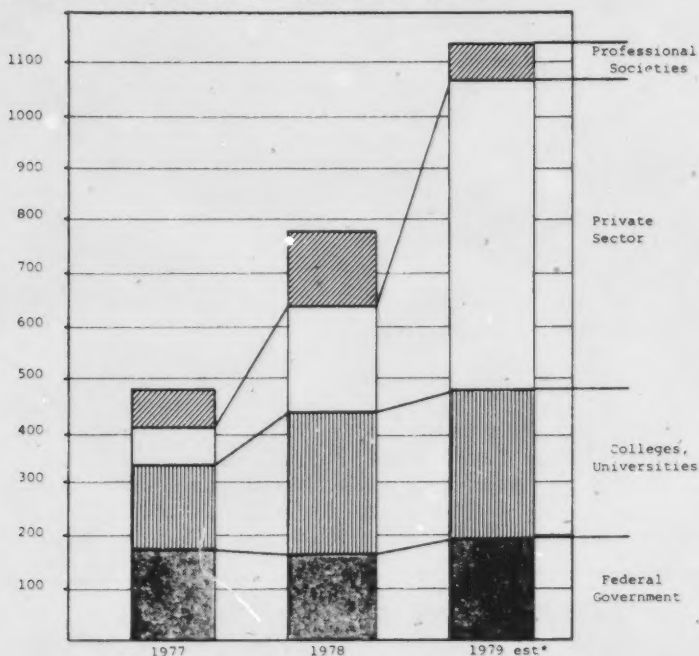
It became clear through initial contacts with state air offices that staff development and training are key to the performance of these functions. We were told that states cannot afford to hire highly trained or experienced personnel: recruits are mostly straight out of school, occasionally with a background in engineering or science. They almost never have training in air pollution or in environmental control programs. States therefore have to rely heavily on training courses available from EPA itself, and they argued strongly that EPA should expand its training program in quality, depth, and availability.

We decided, therefore, to investigate staff training problems in some detail. We wanted to know if air programs are in any way unique. After all, staff development is an issue in every organization, particularly in new ones and particularly where money is tight. The major questions were: (1) where could training come from to support state air programs, and why isn't it making its presence felt, (2) are there really any unusual chronic staffing problems in this area, and why do they exist, and (3) what should EPA do about air program training needs beyond what it currently does?

Looking to the marketplace for help

A convincing argument can be made that it is both unnecessary and inappropriate for a regulatory agency like EPA to support training for its own programs. Once demand for certain skills is established, the marketplace will fulfill professional needs on its own. Universities, private corporations, professional organizations — these and others will step in with whatever general degree coursework, specialized short-courses, or informal professional contacts any field needs to train new people and keep existing staff up to date. Following this argument, the Office of Management and Budget has at various times required EPA to phase out training grants for graduate environmental health education, and to charge tuition for state and local officials attending EPA sponsored courses.

In point of fact this argument usually proves correct: a recent study by the Harvard School of Public Health*, for instance, shows that environmental course offerings have grown considerably in recent years, more than doubling between 1977 and 1979. As Figures 1 and 2 show, growth of course offerings in the private sector appears to be particularly healthy, and air courses are well represented overall.



Source: Moeller, *op. cit.*

*Data collected for first half year; total estimated at twice this number, consistent with data from previous two years.

Figure 1

The Harvard data on short courses show a significant upward trend in the aggregate, and a falloff in the proportion provided by the Federal government, including a documented absolute decline between 1977 and 1978. The non-Federal absolute and proportional share is increasing markedly. Colleges

*Dade W. Moeller, *op. cit.*

Category	Number of Courses and Percent of Total			
	1977 Number (%)	1978 Number (%)	Jan.-June 1979 Number (%)	Projected* for the Year Number (%)
Air Pollution	152 (31.7)	132 (17.0)	92 (16.1)	184 (16.1)
Water Purification	15 (3.1)	70 (9.0)	39 (6.8)	78 (6.8)
Wastewater Treatment	41 (8.6)	83 (10.7)	40 (7.0)	80 (7.0)
Radiation Protection	38 (7.9)	49 (6.3)	23 (4.0)	46 (4.0)
Solid Waste Management	14 (2.9)	43 (5.5)	43 (7.9)	90 (7.9)
Industrial Hygiene and Safety	148 (30.9)	256 (32.9)	236 (41.3)	472 (41.3)
Energy & the Environment	8 (1.7)	11 (1.4)	2 (0.4)	4 (0.4)
Analytical Methods	20 (4.2)	27 (3.5)	11 (1.9)	22 (1.9)
Environmental Modeling	5 (1.0)	12 (1.5)	0 (0.0)	0 (0.0)
Statistical Evaluations	8 (1.7)	1 (0.1)	2 (0.4)	4 (0.4)
Medical & Biological Aspects	7 (1.5)	8 (1.0)	5 (0.9)	10 (0.9)
Toxicology	9 (1.9)	22 (2.8)	31 (5.4)	62 (5.4)
Legal Aspects	11 (2.3)	45 (5.8)	8 (1.4)	16 (1.4)
Policy & Management	3 (0.6)	18 (2.3)	37 (6.5)	74 (6.5)
Totals**	479 (100.0)	777 (99.8)	571 (100.0)	1142 (100.0)

*Estimates for calendar year 1979 were obtained by doubling the number of courses presented during January through June.

**Totals may not be exactly 100.0% due to rounding errors.

Source: Moeller, *op. cit.*

Figure 2

and universities are increasing the number of special training courses fairly significantly, but the greatest increase is from private industry — 752 percent overall, or about 274 percent per year. On the whole, this data perfectly supports the market theory of training, even including the correctness of having the Federal government back out of the field in favor of the private sector.

But looking closer, the states' contentions appear to be borne out. In the same period described, air pollution training actually declined in absolute terms, and dipped sharply in proportional terms relative to other subject areas. From 152 courses in 1977 (31.7% of the total), air pollution training dropped off to 132 courses in 1978 (only 17.0% of the total). Since

EPA offered 80 of these courses in FY 1977, 82 in FY 1978, and 87 in FY 1979, the decline is clearly occurring in the non-Federal sector, and it is steep. Air pollution training showed by far the largest drop in share of total training courses in any of the areas Harvard studied, losing 15.67 percentage points. The other principal loser — radiation protection — lost 3.9 points.

This evidence seemed to indicate that training for air pollution control is for some reason a unique field with unique problems. To answer this study's questions it was necessary to look in some depth at the dynamics of EPA's air program itself, and to study the states' staffing profiles in some depth. With this as background, it is then possible to see more clearly what the real issues are in relation to EPA's role in the training area.

The Air Program: Complex Demands and Constant Change

While air pollution control predates the Clean Air Act by centuries, that law radically altered and expanded the field, changing what had before been primarily a local nuisance control function (odor and smoke control), and expanding it to be a true public health field with uniform national coverage.

Scientific analyses of air pollution's health and welfare effects are now the basis of air pollution control, supplanting less rigorous past practices. State air pollution control programs therefore require a complex mix of technical skills — sophisticated meteorological evaluations, complex air sampling and analysis, detailed engineering studies of evolving control technology. They also involve such disparate fields as law, transportation and land use planning, and public administration. These are, by and large, established professions. What appears to make state air program staff requirements unique is that (1) air pollution control is emerging as a specialty area in each field, (2) many positions require competence in more than one field, and (3) program requirements are constantly redesigned.

Administrative and technical changes are a fact of life and a source of permanent stress at all implementation levels, Federal and non-Federal. Administrative changes are partly ascribable to the substantial revisions of the Act in 1977, but they are also caused by the courts and by EPA's interpretations of vague, controversial, or complex sections of the law. Technical changes arise from the results of new health research, which can lead to the addition, subtraction or revision of ambient or emissions standards; they also result from technical improvement in emissions controls, which states are

expected to administer in their permitting and enforcement programs.

Both types of change force states to reevaluate and often to revise their standard operating procedures, and frequently to reorganize or revise their staffs. Operating changes must usually be done within schedules linked to legislated deadlines in the Act, complicating the attainment of both, and accounting at least in part for the general failure of air programs nationally to meet their timetables. The states are seldom up to date and operating under a stable set of procedures and expectations. To take a few examples. . .

For the monitoring program, recent new responsibilities include the NAMS system, which requires a new series of reports and a new network of stations. Changes in instrumentation puts stress on staffs, since limited states budgets call for most maintenance and repair work to be done in-house — learning procedures for a new instrument takes time. As new pollutants are added to the NAAQS or NESHAPS lists, new monitoring and laboratory analysis responsibilities are added to the program's list of duties.

Changes are more frequent for the permitting and enforcement sections. Periodic updates to many categories of regulations and guidelines (NSPS, NESHAPS) require staff to be familiar with new control technologies and inspection procedures. States performing PSD work become responsible for politically sensitive PSD increment allocations, and must also perform complex BACT determinations and sophisticated air diffusion modeling. Regulatory reform proposals like the bubble concept require further changes in thinking and increasingly sophisticated technical judgments.

The SIP process is deliberately designed to be a continuing effort. Substantial updates to the various SIPs were required by the 1977 Amendments, and as our study was under way, complete SIPs were still lacking in several states more than a year after the Act's deadline. For many non-attainment areas, furthermore, extensive additional planning is required where compliance with national standards cannot be attained by 1982.

Most important, the 1977 Amendments appear to have accelerated the rate of change in the air program. They have added new layers of requirements which, like all others in the air program, are subject to evolving interpretation, periodic updating, court challenges, and technical revision. Worse, states feel that new policy initiatives and regulations are not

fully explained nor developed with an eye toward implementation. Supporting publications are felt to be inadequately documented, and it is usually difficult to identify the author of a given document, the supporting literature, or even another person in the field with relevant experience. States are therefore increasingly unable to offer companies adequate justification for the controls they impose, and cannot properly defend themselves when challenged by their legislature, the public, or industry.* While states are sympathetic with EPA's internal deadlines and constraints, they feel that EPA's difficulties have had an adverse impact on their own planning efforts.

This short glance at the dynamics of the Federal program shows that training needs span a wide range, encompassing both general professional training in a variety of necessary fields, and specialized training to support new responsibilities and requirements. With this in mind let us turn to our analysis of state staffs as our survey revealed them.

Profile of state training needs

At the time at which this study was conducted, to our knowledge no one had conducted a systematic evaluation of state staffing in the air program — or in any other environmental program managed by EPA. We therefore had no baseline against which to compare our approach or our data. The survey on which these results are based included 15 states, selected to represent a spectrum of "staff-to-problem" ratios. Knowing the total size of each state's program staff, we compared this to EPA data on each state's total estimated particulate emissions; the assumption was that this value at least loosely corresponds to the total size of the industrial permitting load.** We then selected five states each with low, average, and high staff-to-problem ratios to be our survey sample. To the extent possible, we then conducted telephone interviews with each program's director, and the heads of the monitoring, permitting, enforcement, and planning staffs. Interviews averaged 45 minutes. The survey did manage to cover all staff

*The problem of poorly drafted regulations and lack of understanding of practical implementation problems is illustrated by the case of the director of the enforcement section of a well-staffed and experienced state, who himself had many years of experience in the program. He said that he had gone over the freshly revised new source performance standards for steam electric plants four times, and was still unsure of how to apply them to a real powerplant.

**The same exercise was conducted for SO_x emissions; happily the results were virtually identical.

with the specified major job responsibilities whose training needs we wanted to explore.

The survey had two main parts. To assess the validity of the need for air pollution courses, we analyzed the backgrounds of the staff and the reasons why states could not hire or keep qualified people. To see whether EPA must provide these courses or if some other provider is feasible, we asked states about the advantages, disadvantages, and availability of other sources of air pollution training.

General Findings

States do not hire adequately trained staff for their air programs — their staff are trained on the job. In essence, the states served as a conduit providing trained staff to other employers. *The states are not equal competitors in the job market.* Once trained (at state or Federal expense), most staffers leave state employment for better paying jobs elsewhere. Job mobility is one-directional — from the states to other sectors of the relatively small job market in air pollution control that does exist: in industry, consulting, the Federal government.

Only eight percent of the management staff running the programs have formal training in air pollution control, with similar or lower figures prevailing in areas such as permitting and enforcement (seven percent), SIP planning (four percent), and monitoring (eight percent). No pattern was found in levels of training prevailing between states with different sized air programs, or different apparent levels of air pollution control problems.

While engineering degrees are favored within the programs, the proportion of engineers is declining overall. Furthermore, states hire comparatively few employees with advanced degrees. Figure 3 summarizes our general findings on staff educational backgrounds. It shows that the bulk of air program jobs are filled with staff holding bachelor's degrees or less; Master's degrees or better are held by 18 percent of permit-tors/enforcers, 13 percent of planners, and seven percent of the monitoring group.

While one can argue that advanced degrees, or even engineering degrees, are not intrinsically required by the nature of the air program, advanced training in relevant fields, particularly in engineering, does make it easier for employees to pick up the technical elements of their duties. Without such advanced training, it would seem appropriate for states to employ personnel with compensating levels of appropriate job

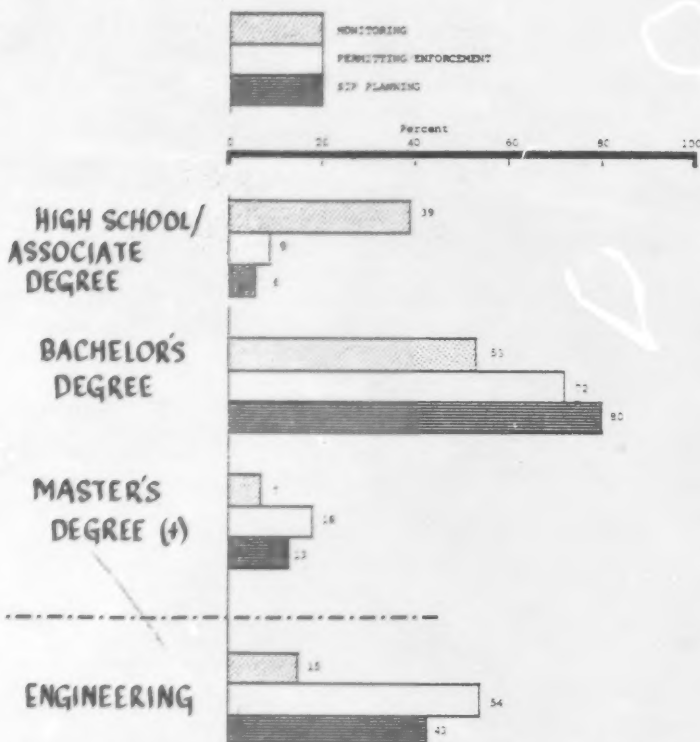


Figure 3: Percent of Job Responsibilities Filled with Various Types of Educational Degrees

experience, such as employment in another state's air program, or a relevant industrial or consultant job. They don't. They can't.

As Figure 4 shows, many states are staffing important parts of the programs entirely with staff directly out of school. Not counting management jobs, over 50 percent of the states surveyed had laboratory, air quality modeling, SIP planning, stack sampling, or monitoring staffs *consisting entirely of people with no prior job experience at all*, let alone relevant job experience. Even in the permitting/enforcement area — probably the most technically demanding segment of the program — 25 percent of states were in this category.

Exact statistics on where employees went after their state

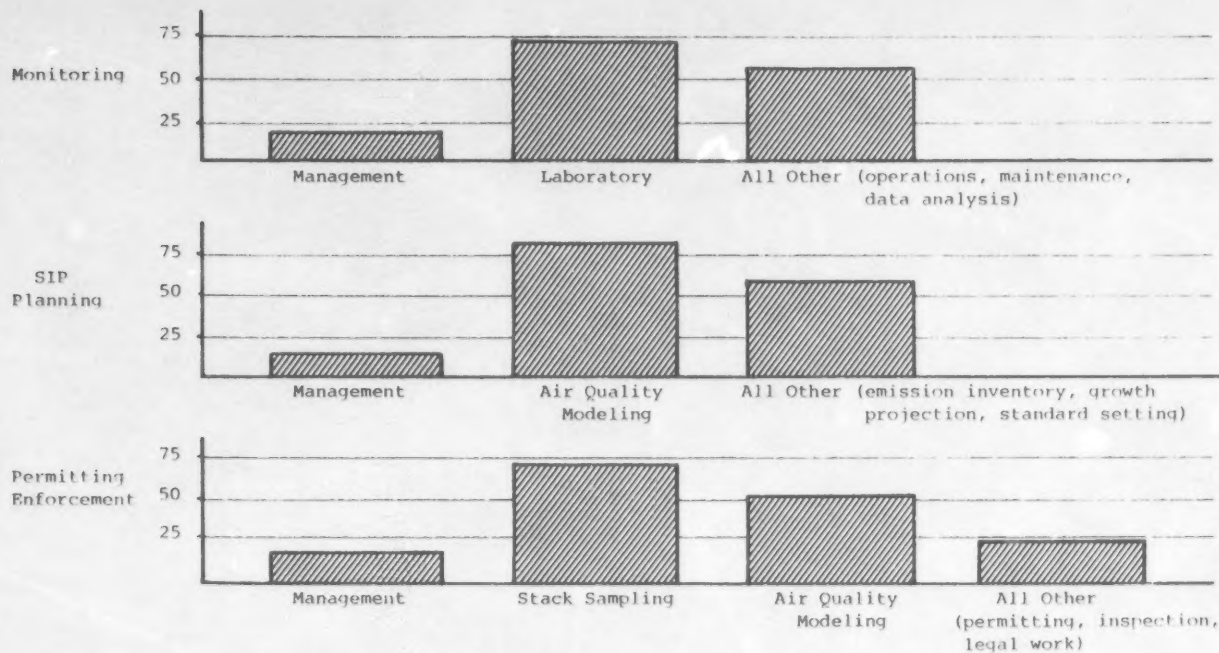


Figure 4: Percent of States Reporting Staff Categories Filled Entirely by People with no Prior Job Experience.

jobs were unobtainable, but the most frequently cited destinations were industry and consulting. The overwhelming reason for employees leaving the states was money. The next most important reason was the lack of job advancement possibilities. There is little state agencies can do to address either of these problems, which are set in place both by uniform civil service requirements (which allow no exceptions across state programs), and by chronic state budget shortages overall, which if anything have become more severe since the year we conducted our study. Only management staff appeared to have other reasons for moving on, and often they expected to say until retirement.

State programs employ 4,201 professionals nationwide.* Assuming that the 13 percent annual attrition rate found in our own study is representative, and assuming no growth in state program size, then state agencies need 546 new people each year. Existing institutions offering both graduate and undergraduate coursework in air pollution do not graduate that many students each year, and of those that graduate, most go to work for industry. Between 1973 and 1976, 94 schools graduated 535 students (bachelors degree or better), but of these only 30 percent went to work for government.** There is also reason to believe that the number graduating annually has declined since then. EPA, for instance, supported 220 students at 19 institutions during that period; currently they support only 25 at nine schools. With this cutback in EPA support, universities have reduced the size of their air pollution programs.

Monitoring Staffs

Of all the areas in the air program, monitoring sections are the most dominated by pure technicians. The major work elements — operations and maintenance, laboratory work, and data analysis — have fairly strict work scopes, and well defined end products. We gained a sense from interviewing the directors that the monitoring sections have a higher than average feeling of satisfaction with their work. They know what they are supposed to do, and are largely left alone to do it.

Because a considerable amount of the work can be handled

*Figure supplied by Jean Schueneman, EPA Manpower Technical Information Branch, Office of Air Quality Planning and Standards, Research Triangle Park.

**Figures from Frederick Stinson, "Supply and demand in training and utilization of professionally qualified air pollution practitioners," *Journal of the Air Pollution Control Association*, Vol. 27, Oct. 1977.

by lower level technicians, monitoring groups can use a comparatively high percentage of labor below the B.S. level. In total, 39 percent of those working in various sections of the monitoring program had either a high school or an Associate's level degree. Only seven percent had a Master's degree, and only 15 percent overall had any engineering training.

Operations and maintenance personnel install equipment in the field, read the instruments, take samples, repair and maintain machines, and often tabulate and analyze the data once it is collected or analyzed by the lab. These people clearly require a combination of skills not formally taught in schools in any one program: the best suited job applicants would have a mixture of electrical and mechanical engineering in their backgrounds. Given the low salaries available from the states, virtually none of the O/M staff actually have appropriate former training; at least on the low end of the O/M pay scale, a few states regarded their recruits as virtually "coolie labor." Managers generally indicated that this job is quite satisfying to those doing it, but that the value of the mix of skills acquired on the job is marketable enough that staff leave for much higher paying jobs elsewhere, generally in industry, where they often wind up doing work unrelated to air pollution.

Lab staff in monitoring sections had the most predictable backgrounds. Seventy-five percent held B.S.'s in chemistry or (infrequently) in another scientific subject. Turnover in lab staff was lower than in any other category of non-management labor in the air program: 12 percent versus an average in other monitoring jobs of 23 percent, and a range elsewhere of 13 to 24 percent. This is probably because this work is most comparable to equivalent work elsewhere, and salary differentials between public and private work in the same job class are lower.

Three quarters of the data analysts jobs we covered were filled by staff that also held O/M responsibilities. Educational background was equally split between bachelor's and Associate's degrees (40 percent each); 13 percent were engineers. Prior job experience was rare. Turnover was about 25 percent per year. Data analysis was evidently considered an undesirable job.

Permitting/Enforcement Staffs

The nature of permitting and enforcement work tends to preclude the use of staff without formal degrees. This group employs only 12 percent with less than a B.A. and 18 percent

have a Master's degree or better. Fifty-four percent are engineers. Non-engineering staff have degrees in the physical sciences (usually chemistry or physics).

Several states reported difficulty in gaining and holding qualified staff with engineering degrees. Many rely on military veterans, others on staff who have recently retired from their careers elsewhere, and who are willing to work several years more for salaries lower than recently trained graduates might receive in the private sector. One state admitted outright that they were consciously looking for B.S. degrees rather than engineering degrees, since state salary scales were no longer competitive in the engineering market. Others mention that civil service requirements were making it more difficult to attract qualified engineering graduates. Overall, turnover in the states surveyed average 11 percent in this general category.

Of all the groups in permitting or enforcement sections, inspectors had the least formal education, employed the fewest engineers, and had the most high school and Associate's degrees (19 percent). Only two of the 103 inspector's jobs surveyed were filled by staff with any prior experience in air pollution work. Turnover appeared to be about 14 percent per year; primary destinations for those leaving were industry or consulting firms.

Permitting had the highest consistent level of academic training after air quality modeling. None of the permitters we surveyed held less than a bachelor's degree, 20 percent held Master's degrees or better, and 71 percent were engineers. The engineers came mainly directly out of school, but a substantial number had prior experience in the military or were senior employees nearing retirement. Permitters also had the highest percentage of prior experience in air pollution work of any category (about 12 percent), and seven percent had academic training related to air pollution.

Of the staff doing air quality modeling work, only 27 percent were reported to have formal training in modeling itself, and only 18 percent had had experience in modeling or meteorology prior to coming to the state. Many of the meteorologists employed in modeling got their training in the military. Turnover was found to be 19 percent per year, with most leaving for higher paying work in the private sector (usually consulting firms).

We included stack samplers in our permitting/engineering group, although some states include them with monitoring sections. Eighty-six percent held bachelor's degrees, and 62 percent held them in engineering of one sort or another. Turnover

for stack samplers was high — 27 percent per year — but easy to explain: working conditions are poor (they are outdoors most of the time, often in bad weather and in hazardous situations), and there is no career advancement beyond crew leader.

SIP Planning

SIP planning staffs were the least well defined in terms of separation of staff function. One state had its SIP partly compiled by its monitoring staff, and two others used their permitting and enforcement groups to design and compile most of their SIPs. SIPs — the central planning instrument for the entire state programs — are compiled predominantly by staff with bachelor's degrees: 82 percent hold B.S.s, 11 percent less than a college degree, and ten percent had Master's degrees or better. Forty-one percent were engineers, but only four percent had air pollution training. Only six percent had prior job experience in the field.

SIP responsibilities were occasionally described as the most stressful of the three groups, since they demanded the most creative thinking and had the least structured guidance.

Managers: All Categories

Most managers in the air programs are promoted from within, not hired from outside. It then follows that their formal training in air pollution control work is no more extensive than most of their staffs, nor is their previous job experience. Naturally, they have more direct on-the-job experience in the subject in their present positions than do their staffs.

As in similar technically-oriented programs, managers in air programs have little formal management training. For the most part they are scientists or engineers. Management training itself is also low on their lists of staff development priorities, since the focus of what little training effort they can afford has to go to support their staff's training needs.

Turnover on management staffs is generally lower than for other categories, averaging about seven percent overall.

Training Sources and Preferences

Without exception, all respondents reported that their staffs receive informal on the job training of one form or another. Often they spoke of apprenticeship periods, during which new employees simply followed senior staff around to learn by watching (if not doing); this was especially true where mechanical skills were involved, and during the apprenticeship phases, new employees were not expected to contribute much

useful work. Apprenticeship could last as long as a year for some of the more involved activities, like permitting. Most states were too concerned about keeping up with existing workload to design explicit training curricula for new staff, but a few held relatively structured in-house seminars for new employees.

EPA-sponsored courses are most popular

Of all the sources of formal training available, EPA's training courses, offered through RTP, were by far the most popular. Within the survey sample, majorities of all categories of managers reported using the EPA courses extensively, either at RTP itself or (where possible) in the traveling versions that are held across the country. In monitoring, 92 percent relied frequently on the courses at RTP, and 77 percent relied heavily on traveling courses. In permitting, the figures were 71 percent and 50 percent respectively, and for SIP planning 53 and 60 percent. The relatively low frequencies for SIP planning is probably due to the lack of course offerings in SIP subjects. Wide majorities of all managers also indicated that they wanted to use the courses the same or more in the future.

Although all the states relied on these courses, opinions about the general quality and importance of the offerings varied markedly from state to state. One felt that the courses were usually much too elementary for the quality of staff they employed; three states commented that the courses tended to be out of date. But even the most opinionated respondents (pro and con) did not give a blanket rating to all courses: *any course described as useless by one state was termed essential by another*. And every state surveyed, even the most critical, felt that at least some of the courses were crucial to effective job performance of their staff.

Other sources of formal training used infrequently

We also asked about a full range of non-EPA training options, from full time degree programs to commercially-available one- or two-day short courses. Confirming the results of the Harard study, we found that these other sources of formal training were used infrequently, and were essentially inconsequential in relation to carrying out day-to-day responsibilities. They were used more for their convenience than for their content or quality. Where they were used frequently, these other training sources either filled in very specialized needs (such as learning how to use a specific brand of monitoring instrument), were not aimed at air pollution *per se*, or were

"perks" given out with roughly equal access to all state employees (e.g., continuing education in pursuit of general academic degrees).

Local part-time degrees seldom appear to cover subjects related to day-to-day responsibilities. Even though most programs were located in state capitals, usually close to state universities, few academic programs were cited as close to state responsibilities. They were more in the way of general career advancement. It was not surprising to find the greatest use in the monitoring sections, which tend to employ the largest number of high school and trade school graduates. The courses taken were in general electronics or mechanical engineering. Few managers appeared to use this type of training when tuition was a factor. Where tuition was supported, states tended to pay it from a source outside of air program funds.

Local academic short-courses were felt to have the same drawbacks as local part-time degrees. Few appropriate courses exist, and few are expected to be available in the future. Where there are some topics that appear useful, managers were not willing to use them when policy matters or specific regulatory matters are involved: in such situations EPA was regarded as the only appropriate authority. *Distant academic short courses* had somewhat different drawbacks. While a greater number of appropriate courses is available when one is willing to incur travel expense, lack of adequate publicity and travel costs are major negative factors. The more important inhibitor is travel. When a state decides to fund travel for training, it is more likely to send trainees to an EPA-funded (tuition free) course. Managers tended to report overall that few truly appropriate short courses are offered at universities, local or distant.

Commercial short-courses appear to have a role when their content can be reduced to replicable material and when their duration is short (two or three days maximum). The most popular commercially provided short courses were those given by vendors of monitoring or laboratory instruments on how to use their products. No significant competition with EPA's general training curriculum appeared to be available from industry or consulting firms.

Self-instructional courses were reasonably popular, but no source of this material other than EPA was discovered. EPA's slide/tape and video tape materials were almost equally popular, each with its own advantages and disadvantages. Frequently cited advantages were cost and convenience; one less

recognized advantage was the ability to deliver kinds of information a regular classroom setting could not — like how to perform stack sampling properly. Most often cited disadvantages were lack of ability for students to interact either with each other or with an instructor, poor presentation material on many of the video-tapes available, and difficulty in determining how well students absorbed what they were taught.

The EPA fellowship program and correspondence courses were also included in the survey's discussions. Air program staff had virtually no experience with either.

Cost is the major factor inhibiting use of formal training

States are extremely sensitive to both principal elements of training costs: tuition and travel. Simple regression tests on attendance data from courses offered at RTP show that, during the years in which tuition was charged to state and local trainees, the dropoff in attendance by this sector (more than fifty percent) was significantly correlated. By contrast, similar tests on attendance of private sector trainees show no such significant correlation.

Managers from most (but not all) states indicated their budgets were insufficient to pay for even modest tuition charges. Even though EPA's temporary charges were low, they became a major factor when multiplied by the number of class days required.

Travel costs and travel limitation policies continue to be a major problem, accounting for the marked preference for traveling courses over RTP courses (to the extent they are available). Virtually all states indicated they had moderate to severe budget constraints on travel. Full year travel/tuition budgets (the two were *not* considered separately) were generally quite low — in the \$2,000 to \$10,000 range for the states surveyed. Only a handful of states considered that travel costs were not a significant constraint.

Equally as important as actual financial limitations were externally imposed state limitations on travel. There were many variations to this issue, all with the fairly transparent political motive of avoiding even the appearance of abusing the travel privilege. Some states had complete (ostensibly temporary) bans on out-of-state travel, others had a list of proscribed destinations (the south, the west, the coasts). In some, the season of the year was a factor — winter trips to warmer climates were frowned upon by some. Equally a problem were arbitrary restrictions on the number of employees who could travel to one destination. Few states allowed more than one

employee on leave to the same place at the same time, even if travel funds permitted. This is a considerable problem in relation to traveling short courses, since it tends to wipe out most of the travel cost advantage they offer.

States had few ideas on how to get around travel problems. A few agreed with ideas like earmarking 105 funds, or holding funds in escrow in the regions for states to draw on for travel, but neither idea was supported by a majority of respondents.

CONCLUSIONS

Even if EPA's training programs were to be drastically curtailed, it is unlikely that some other source of formal job training would emerge to replace it. In this respect that air program is an exception to an otherwise generally applicable rule: that the private or semi-private sector will step in to fill training needs to a Federal program if Federal support is withdrawn.

From our survey it is clear that both the relatively small size of the nation's total air pollution control training needs, as well as the need for authoritative Federal advice on this complex regulatory area, yield no alternative to the Federal model.* Most importantly, states cannot compete in the limited job market that already exists to supply qualified professionals to the air pollution control community, they simply cannot afford the salaries. We have, in fact, found that states are functioning as a training ground for the private sector, and that there is insufficient demand for technical training to support the many local training programs that most states would need, or could afford to use. Especially if the Reagan Administration intends to increase the degree to which EPA delegates Federal regulatory functions, the obligation for increasing both the quality and quantity of Federally supported training seems to us inescapable.

While both the basic "core" curriculum courses and more specialized advanced coursework are in demand, support in relation to core course needs seems the more important focus for the foreseeable future. Given the continuing turnover of state staffs, training at the core curriculum level must be considered a permanent need. Whatever can be done above and beyond this to cover needs for advanced topics must be of secondary priority.

*The one exception appears to be in relation to monitoring: there it may well be possible to turn more of the burden of training over to vendors of equipment. This might be done through procurement contracts that include purchase of necessary training within the capital cost of the instruments.

Perspectives on options for better training

As we have sought to demonstrate above, better training in the air program means increases in both quality and quantity. Both entail new expenses, the question is how much can the government afford.

Improvements in classroom setting work would mean an increase in the number of courses offered on the road — this would allow states with intractable travel restrictions to take better advantage. Increases in quality would mean expansion and updating of course curricula, and perhaps some attempt to match the level of a given course to the particular audience attending; even within the core curriculum, a course considered advanced by one state can be considered elementary by another.

Today's budget climate is not particularly likely to support significantly increased investments in formal classroom training, cost-effective though that may be. Two alternate mechanisms for improving the level of training delivered to states are lower in cost and perhaps adequate in technical coverage: they are (1) the production of new manuals and guidebooks, and (2) better audio-visual materials.

During 1971, EPA spent \$2 million on the production of manuals and guidebooks in the areas of inspections, permitting, and monitoring. No new books have come out since about 1972 except on air quality modeling and the air quality maintenance programs. Demand for these volumes persists, even though they are out of print and out of date. Clearly a new round of guidance materials is overdue.

Audio-visuals, especially video-tape production, are a much closer substitute for formal classroom work than written manuals. To make them as strong as possible, we recommend that EPA consider training regional or state staff to deliver audio-visual courses in a much more formal way than before. Staffers should no longer simply listen to the audio-visuals without supervision; a leader ought to be present to answer questions, run discussion sessions, and administer tests. The courses themselves could also be much improved in production values, getting away from the taped workshop format so common now, and making increased use of graphics and sophisticated TV teaching techniques. Such improvements would be expensive, but they would effectively eliminate many of the impediments to training (especially travel restrictions) that now seem so difficult to resolve.

ACKNOWLEDGEMENTS AND COMMENTS

This paper is largely based on the report, "Analysis of EPA Technical Assistance to State and Local Governments: Vol. 1, Air Program, Training Needs," written by the authors at Urban Systems Research and Engineering, Inc. The project part of a larger effort to review technical assistance needs in five EPA program areas: air, surface water, drinking water, solid waste, and noise. Its content is partially updated to reflect recent opinion regarding EPA's air pollution training courses.

We are grateful to Tom Kelly and Steve Jackson of OPE's Program Evaluation Division for the help and support they gave over the course of this study. Thanks too to Jean Schueneman and others involved in EPA's training program, and to the many state officials who provided many hours of their time to discuss the many issues involved in this interesting field.

* * *

The air program is highly complex, and like every regulatory program has an evolved jargon of its own. To keep this paper short, the authors have presumed that readers have some knowledge of the program's structure and terminology. We have tried to keep acronyms to a minimum; those that inevitably creep in are glossed briefly *in a list at the back of this paper.*

DISCLAIMER

This paper was written by Michael R. Alford in his private capacity. No official support or endorsement by the Environmental Protection Agency or any other agency of the Federal government is intended or should be inferred.

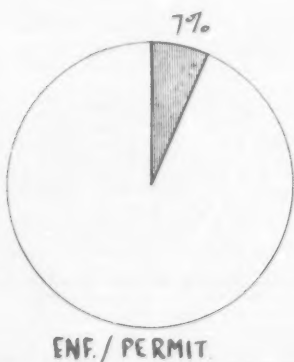
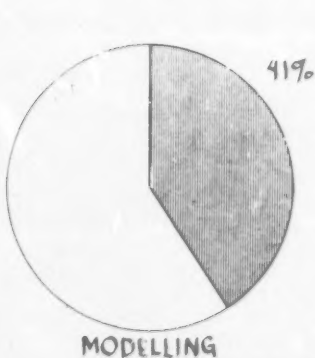
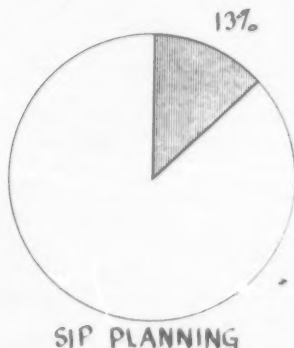
GLOSSARY

BACT	Best Available Control Technology — technology-based emission control requirements imposed on new stationary sources of air pollution
NAAQS	National Ambient Air Quality Standards
NESHAPS	National Emission Standards for Hazardous Air Pollutants

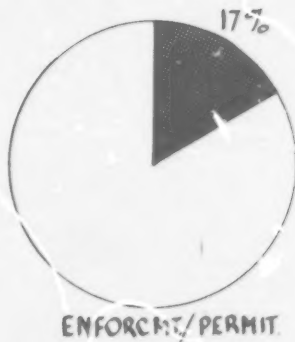
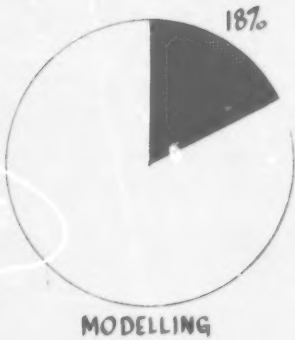
O/M	Operation and Maintenance
PSD	Prevention of Significant Deterioration — national regulations to maintain existing ambient air quality
RTP	Research Triangle Park, North Carolina — EPA's Office of Air Quality Planning and Standards which houses the Air Pollution Training Institute is located in this city
SIP	State Implementation Plans — the compendium of state laws, emission and ambient air quality standards, monitoring program, and implementation strategy designed to achieve and maintain NAAQS throughout the state

APPENDICES

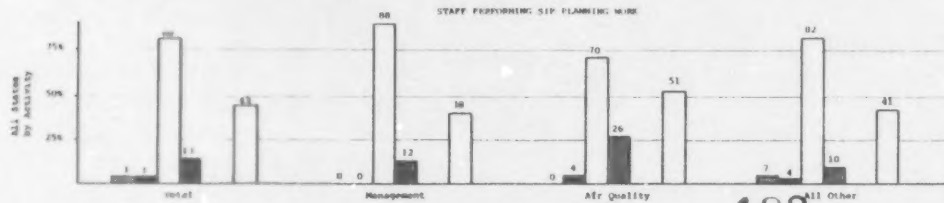
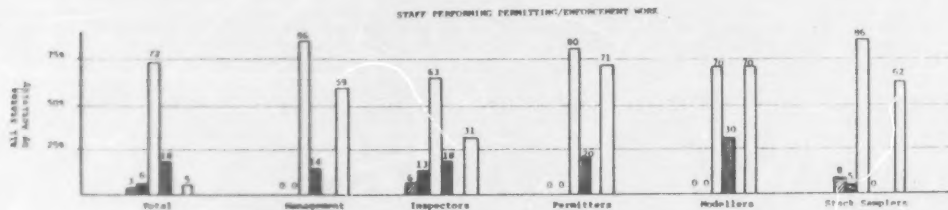
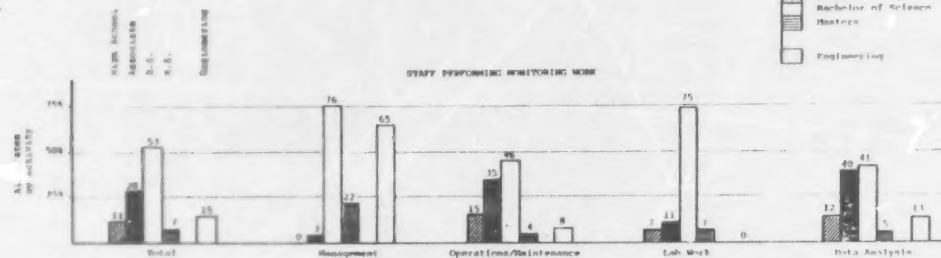
Percent of Staff with Prior Formal Training



Percent of Staff with Prior Air Pollution Experience



Staff Performing Monitoring Work



Staff Turnover For Fiscal Years 78, 79 and 80Alabama Air Pollution Control Commission

The list below identifies the classification and experience of the individuals who resigned from the agency during fiscal years 78, 79 and 80. None of the new employees acquired had previous experience in air pollution control.

The staffing level remained essentially constant during this period at about 50 employees.

10/1/77 - 9/31/78

<u>Last Working Day</u>	<u>Classification</u>	<u>Experience</u>
12/29/77	Public Health Engineer II	5 years
3/24/78	Public Health Engineer II	7 years

10/1/78 - 9/31/79

<u>Last Working Day</u>	<u>Classification</u>	<u>Experience</u>
10/17/78	Public Health Engineer II	5 years
11/28/78	Pollu. Control Spec. II	6 years
6/6/79	Res. Use Planner I	2 years
3/29/79	Pollu. Control Spec. II	5 years
9/28/79	Env. Health Spec. II	4 years
8/10/79	Attorney I	7 months
9/5/79	Pollu. Control Spec. II	4 years

10/1/79 - 9/31/80

<u>Last Working Day</u>	<u>Classification</u>	<u>Experience</u>
10/9/79	Chemist II	6 years
10/19/79	Pollu. Control Spec. III	5 years
12/11/79	Hel. Ser. Adm. II	3 years
12/25/79	Clerk-Steno I	2 years
1/4/80	Pollu. Control Spec. II	4 years
1/18/80	Clerk Steno II	3 years
2/1/80	Laborer	3 years
5/9/80	Legal Research Aide	6 months
5/13/80	Clerk-Steno II	9 years

	COURSES AT BTF	TRAVELING EPA COURSES	LOCAL PART-TIME DEGREE	SHORT COURSE LOCAL U.	SHORT COURSE DISTANT U.	INDUSTRIAL/ CONSULTING SHORT COURSE	SELF-IN- STRUCTURAL	VIDEO- TAPE	EPA FELLOWSHIP
FREQUENCY OF USE:									
Frequent (%)	92	77	31	0	0	8	15	0	0
Occasional (%)	8	15	18	46	42	31	69	75	50
Seldom/Never (%)	0	8	31	54	58	62	15	25	50
PREFERENCE FOR USE:									
Less (%)	8	0	0	0	0	0	8	17	13
Same (%)	46	31	46	46	83	69	46	25	88
More (%)	46	69	54	54	17	31	46	67	0
EVALUATIONS: Number of States Commenting									
1. Exposure/Publicity									1
2. Cost		3	2			1	1	2	1
3. Popularity with Staff				1	1			2	
4. Availability			1				1	1	1
5. Accessibility		5	1				1		
6. Effectiveness (Job Performance)	7	3	3	3	1	4	4	5	
7. Travel Policy		8							
8. Demands on Staff Time				1					
9. Staff Travel Preference				1					
10. Quality/Content	8	1	2	1		1	4	6	2
11. Fringe Benefit			3						
12. Equipment Availability					1				
1. Exposure/Publicity	1			2	2	2			2
2. Cost	3		3		3	3			1
3. Popularity with Staff					1		4	1	1
4. Availability	1	4	2	9	3	4	2	4	
5. Accessibility					1				1
6. Effectiveness (Job Performance)			1			1			
7. Travel Policy	8	2		1	7	3			
8. Demands on Staff Time	1			1	8		1		1
9. Staff Travel Preference									
10. Quality/Content	1	1	1	1	3	1	5		
11. Fringe Benefits								1	
12. Equipment Availability									
	N=13	N=13	N=13	N=13	N=13	N=13	N=13	N=12	N=12

		COURSES AT HCP	TRAVELING EPA COURSES	LOCAL PART-TIME DEGREE	SHORT COURSE LOCAL U.	SHORT COURSE DISTANT U.	INDUSTRIAL/ CONSULTING SHORT COURSE	SELF-IN- STRUCTIONAL	VIDEO- TAPE	GPA FELLOWSHIP
FREQUENCY OF USE:										
Frequent (%)		53	60	13		0	0	15	0	0
Occasional (%)		40	20	40	20	31	21	69	77	21
Seldom/Never (%)		7	20	47	80	69	79	15	23	79
PREFERENCE FOR USE:										
Less (%)		0	13	7	0	0	0	8	0	0
Same (%)		27	40	53	40	62	64	31	54	86
More (%)		73	47	40	60	38	36	62	46	14
Reasons for using mechanism	EVALUATIONS: Number of States Commenting									
	1. Exposure/Publicity									
	2. Cost									
	3. Popularity with Staff			1				4	3	
	4. Availability				1				1	
	5. Accessibility								1	1
	6. Effectiveness (Job Performance)		5	2	1			2		
	7. Travel Policy	6	3		1	2	3	6	5	1
	8. Demands on Staff Time		9		1			2	2	
	9. Staff Travel Preference		3		1			1		
	10. Quality/Content			2	1					
	11. Fringe Benefit	8	4							
	12. Equipment Availability			1		2	3	5	5	2
Reasons for not using mechanism	1. Exposure/Publicity									3
	2. Cost	3		2	1	1	2			1
	3. Popularity with Staff					2	4			
	4. Availability	4	8	7	11	2	3	3		
	5. Accessibility							6		
	6. Effectiveness (Job Performance)	1		2	2					1
	7. Travel Policy	10	2		1		1		1	1
	8. Demands on Staff Time	3		2	1	4				
	9. Staff Travel Preference						1	1		1
	10. Quality/Content	4		2	2	2	5	6		
	11. Fringe Benefit								1	
	12. Equipment Availability								1	
		N=15	N=15	N=15	N=15	N=15	N=15	N=13	N=13	N=14

CONTINUATION OF VARIOUS REASONS OF TRAINING. SEE DRAWING

	COURSES AT RTT	TRAVELING EPA COURSES	LOCAL PART-TIME DEGREE	SHORT COURSE LOCAL U.	SHORT COURSE DISTANT U.	INDUSTRIAL/ CONSULTING SHORT COURSE	SELF-IN- STRUCTIONAL	VIDEO-TAPE	EPA FELLOWSHIP
FREQUENCY OF CURRENT USE									
Frequent (%)	71	60	8	0	0	0	17	8	0
Occasional (%)	14	50	54	31	38	38	58	58	31
Seldom/Never (%)	14	0	38	69	62	62	25	33	69
PREFERENCE FOR USE:									
Less (%)	7	7	8	0	0	0	8	17	8
Same (%)	50	21	46	54	77	77	50	33	69
More (%)	43	71	46	46	23	23	42	50	23
EVALUATION: Number of States Committing									
1. Exposure/Publicity		2					2	2	
2. Cost		1					1	1	
3. Popularity with Staff									1
4. Availability	2	5	1	3			1	1	
5. Accessibility	1						2	1	
6. Effectiveness (Job Performance)	4	2	1	1	3	1	7	5	1
7. Travel Policy		9						1	
8. Demands on Staff Time		1							
9. Staff Travel Preference		5	2	1		3	4	5	2
10. Quality/Content	7				3				
11. Fringe Benefit									
12. Equipment Availability									
Reasons for not using mechanism:									
1. Exposure/Publicity					1	3	1	2	2
2. Cost	5	1	4		5	2			1
3. Popularity with Staff		1					5	2	
4. Availability		5	7	11	1	2	3	3	1
5. Accessibility					1				
6. Effectiveness (Job Performance)			2			1			1
7. Travel Policy	10		1	1	2				
8. Demands on Staff Time	2	2	2	1					1
9. Staff Travel Preference	1		1						
10. Quality/Content	2	1	5	2		6	6		
11. Fringe Benefit								1	
12. Equipment Availability								2	
	N=14	N=14	N=13	N=13	N=13	N=13	N=12	N=12	N=13

EVALUATION OF VARIOUS MODES OF TRAINING:

ENFORCEMENT/PERMITTING

PERCENT ANNUAL TURNOVER IN STATE STAFFS BY JOB CATEGORY AND STATE CHARACTERISTICS

	All Management	Monitor Operation & Maintenance & Data Analysis	Laboratory	Stack Sampling	Stationary Source/ Enforcement	SIP Planning
Low Staff Size/Problem	16%	12%	13%	23%	22%	17%
Average Staff Size/Problem	9%	25%	10%	20%	9%	9%
High Staff Size/Problem	4%	14%	14%	38%	14%	17%
TOTAL	9%	23%	12%	24%	13%	15%
Small Staff	21%	17%	10%	11%	20%	17%
Medium Staff	3%	12%	23%	17%	11%	15%
Large Staff	8%	21%	10%	28%	12%	14%

Manpower and Training Needs for Noise Control and Abatement

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INTRODUCTION

Noise is probably the most subtle yet pervasive of pollutants. It leaves no calling card as does air, solid waste or water pollution. Instead it leaves the danger of debilitating health effects if excessive noise is left uncontrolled and unabated. Some of these health hazards include, heart disease, high blood pressure, insomnia, jangled nerves and measurable loss of hearing, which may range from mild to extreme; depending upon exposure and duration. Noise also hinders communication and thereby prevents learning among our students. Noise invades almost every household in one form or another and pays little regard to social or economic status. Excessive noise will even have an effect upon the unborn.

As much as we know about the effects of noise, there is still much more left to discover. It is only since 1972, that noise has become an issue of national importance, and, when the Noise Control Act of 1972 was passed into law, only then did the Environmental Protection Agency take an active role in the effort to control and abate harmful noise levels. Originally, the Agency's efforts were limited to the regulatory approach to noise control. Under the original statute, EPA was to set standards and issue regulations on products and industries which were determined to be the primary sources of noise. Coupled with regulatory authority for noisy products, EPA embarked on a coordinative role with other Federal Agencies such as the Federal Aviation Administration, Department of Transportation, the Department of Labor and others to provide impetus

and direction to the national noise control program among the Federal Departments and Agencies.

The Quiet Communities Act

In the Spring of 1978, Congress held hearings on the Noise Control Act of 1972 and, as a result of those hearings, determined that the regulatory program as administered by EPA, would not suffice to adequately control and reduce excessive noise in the United States. As a result, Congress enacted the Quiet Communities Act of 1978 which was signed into law in November of that year. The emphasis of the Quiet Communities Act is on the development of complementary State and local noise control programs which would backstop the Federal Regulatory Program. Congress also recognized and reemphasized that noise control is essentially a State and local issue. Without the increased efforts of State and units of local government in this undertaking, the Federal program would not be completely effective. In so many words, Congress said that unless EPA and its Regulatory Program were joined by a strong State and local noise control program, the problem might only get worse.

Until that time, there was very little EPA could statutorily undertake in order to assist States and local governments in their efforts to control excessive noise. The Office of Noise Abatement and Control (ONAC) was limited to providing advice to States and communities on noise control and little more. The Quiet Communities Act changed all that—and empowered EPA/ONAC to establish a State and local financial and technical assistance program in order to increase the number of programs at those respective governmental levels, which would be complementary to the Federal Regulatory Program. The State and Local Programs Division has had the responsibility to carry out the provisions of the Quiet Communities Act of 1978 which amends Section 14 of the Noise Control Act of 1972 to authorize the Federal financial and technical assistance program.

Manpower Needs

One of the first items we decided to address is the examination of the manpower, or personnel requirements of States and units of local government for noise control. Included in that examination was a look at the training and educational requirements of an increasing, or what we hoped would be, number of state and local noise programs. This was by no

means an easy task. In contrast, the state-of-the-art in noise abatement and control at the State and local levels is, at the present time, approximately where the State and local wastewater treatment capability was ten years ago. In this respect, the national noise program has had a lot of catching up to do. In my estimation, it has not caught up yet nor is it likely to unless there is a radical increase in the number of qualified individuals deployed by States and locales to effectively control environmental noise levels.

Let me offer to you some of the highlights of the study performed by a prominent consulting firm relative to the status of manpower and training needs in the noise area.

- "On a national scale, State and local noise programs do not exist with sufficient resources and personnel to actually make a difference in the national noise control program. On the top end of the spectrum of existing State and local programs, the staffing complement is approximately 50% short. In the mid-range and low end of the spectrum, the situation is much more drastic.
- "Many States and locales do not have offices or agency subdivisions which are organized for the specific purpose of noise control. This is in contrast to a growing number of jurisdictions with enabling or noise-specific laws and ordinances.
- "The sophistication and level of expertise required for effective implementation of a program indicates not only a personnel shortage but also a skill shortage. This is true for both existing and projected personnel in almost all States and locales.
- "There is a need for qualitative improvement in noise control personnel which approximates the need for additional personnel. For this reason, programs lack comprehensiveness and adequate macro-scope perspectives. In fact, the current qualitative demand exceeds the quantitative demand.
- "The heaviest burden of States and locales in the implementation of noise control programs is at the initial stages of program development and implementation. At the program development stage, the burden is on proving the need for noise control; at the implementation stage, the burden is precipitated by the heavy front-end or start-up costs in personnel and equipment which many entities are reluctant to address.

- "Lack of staff and resources are the principal manifestations of the relatively low priority assigned to noise control" at the State and local levels.

These conclusions were articulated by the consulting firm we employed to examine the situation only two years ago. Although many of the problems hindering the growth of active State and local noise programs still exist, I am happy to say that we have made some measurable progress in this critical area.

Primary State and Local Programs

At this point in the discussion, I would like to explain exactly what it is that we view as the primary functions of State and local noise control programs. With these points in mind, we can go on to further explain the results of our manpower and training needs assessment.

We view the approach to noise control at any governmental level as one that consists of four distinct, although inter-related, states. The first is the problem of identification stage. By problem identification, we mean the actual measurement of existing environmental noise in an area—coupled with the attitudes of residents of that area. These are ascertained by administering physical and attitudinal surveys which are scientifically applied and enormously accurate at measuring the existing noise in a jurisdiction and in determining exactly what residents of that area think about noise. The problem identification stage, aside from being the most costly for any program, is also the stage upon which the remaining three stages base their need.

Once the noise problems and perceptions have been identified, it becomes necessary to develop a noise control strategy which is aimed at reducing the noise levels most prominently mentioned and identified in the surveys. This strategy development stage of the program takes into account all available alternatives and methods of control which can be used or employed in reducing and controlling the noise levels within the jurisdiction. Once a comprehensive strategy is decided upon, and the responsibilities for implementation assigned, the program moves into the third stage—that of law or ordinance enactment.

In the third stage of the program, and depending upon the nature and size of the jurisdiction, enabling legislation and ordinances are prepared which allow the jurisdiction to effectively deal with the noise problems and issues identified in the first stage of the program. Having examined the alternatives and having decided upon a course of action in the second stage, the

enactment of laws and/or ordinances becomes the next logical step. Once the laws and ordinances are on the books the remaining function of the program is to enforce those statutes and to maintain the integrity of the program through identification of new sources of noise whenever they arise.

This linear, step-by-step approach to noise control is complicated by the fact that there are a number of general categories which make up separate program areas of endeavor and which are normally administered by various governmental agencies at both the State and local levels. They include motor vehicle noise, property line standards, land-use planning, Aircraft noise, public education and awareness and construction noise. Since very few States and locales possess noise agencies which address all of these areas in one comprehensive program, the task of mounting an effective noise control program is compounded in difficulty by the number of separate agencies the noise program will have to coordinate with.

So much for the design and approach to noise control at the State and local levels. As a final word on this subject, we feel that it is up to the locales in almost every instance, to develop active noise control programs for themselves. EPA and the States can only be sources of assistance and act as resource agencies. In the final analysis, it will be up to communities themselves to complete the job.

Detailed Personnel Needs

With this background in mind, we can more fully examine the detailed personnel needs of the State and local noise control programs. In this regard, we have some pretty hard data which is based on a 1979 assessment performed for ONAC by E.H. White and Company, a management consulting firm based in San Francisco. According to the E.H. White study, the personnel requirements of States and local agencies are based on the identification of each task associated with the implementation of the four step approach to noise control. There are tasks which are, for the most part, carried out by a central noise office or a core agency; and there are tasks which can be carried out by auxiliary or other agencies which do not have the main purpose of noise control but do have one or two of the functions—such as a police department. Both sets of tasks have to be coordinated by a central office or core agency which must have overall responsibility for the entire program including handling and processing complaints to reviewing and approving variances to the ordinance.

Thus, the core agency and auxiliary agency tasks were separately identified. Once this was accomplished, the study assigned a person-year allocation to each distinct task and sub-task in the noise control process—for each program area and according to each step in the process. As a result, we have developed a data base from which we can construct the "typical" noise agency by size and type of jurisdiction. By comparing those with what actually exists, we can determine the shortfall of the personnel assigned to noise control at the State and local levels.

To give you an idea as to just how many local and State agencies can be involved in a comprehensive noise control program, let me list the mainstream of those agencies. The Department of Environmental Protection; the Department of Transportation; the Department of Housing; the Department of Public Safety; the Police Department; the Department of Education/Public Instruction; The Port Authority; The Department of Labor or Industry; The Planning and Zoning Department; these agencies at the State level or their local counterparts can each play a critical role in the success of a comprehensive noise abatement and control program. Therefore, the personnel requirements we have seen are not exaggerated but are in line with the contributions of time and resources which could reasonably be expected from each of those departments and agencies.

To put those numerical requirements into a national perspective, we have extrapolated the State and local personnel requirements in order to give us an idea as to how many people will be needed to accomplish the goal of effectively reducing environmental noise levels through active State and local programs. Thus, for the 907 cities in the United States with populations over 25,000 and for each of the States, there is an aggregate personnel need that approximates 20,000 person years to start up and maintain those noise abatement and control programs. A large percentage of those individuals are in place and functioning within their current responsibilities. What needs to be accomplished is the placement of the remainder and the mobilization of their departments and agencies to focus on the problems and issues arising from excessive noise.

With respect to the training needs of the noise workforce, there is, unfortunately, a tremendous need for update and new training for those who will be engaged in the program as the years unfold. The training needs range from simple noise

measurement equipment training to data analysis, and from enforcement of laws and ordinances to applied research in health effects. As previously stated, the training need approaches or exceeds the need for personnel in its scope and depth.

On the bright side, none of these problems or requirements is insurmountable. In fact, we have made significant progress within the last two years to come to terms with the requirements of States and local noise control programs. At this point I'd like to recite some of our approaches and accomplishments. You might even find some of them useful to your programs in other environmental control areas.

Initially, we at ONAC established a goal of initiating 40 active State programs and 400 active local programs in cities where populations would amount to 72 million persons. The target date for this goal is 1985. As a result our entire State and local financial and technical assistance program is geared to meet our goals. Under our legislated authority, we established Regional Technical Assistance Centers which act on the development and training needs of States and units of local government engaged in noise control. These Technical Assistance Centers perform their functions at the direction of the EPA Regional Noise Offices and provide a wide variety of services to State and local programs. These services include training, workshops, seminars and technical on-site assistance at any given stage of a State or local program.

ECHO Program

We established the ECHO concept. ECHO is an acronym that stands for *Each Community Helps Others*. Under this approach, we operated a national ECHO program that utilized a peer-match between communities. For example, if community 'A' has a problem with problem identification and community 'B' has already solved a similar problem, ONAC would provide the out-of-pocket and travel expenses for community 'B' to help community 'A.' In this way we built a cadre of individuals who were willing to lend their time and expertise to another community in order to help that community with its noise problem. The ECHO concept has been extended to the States. In that regard, we now view the States as the primary ECHO providers as part of their regular noise control programs. In fact, we condition our financial assistance to States that are willing to assume the ECHO posture in relation to their constituent communities. The concept is working well and is resulting

in a growing number of active local programs as well as State programs.

We have placed a great deal of faith in the public awareness and public education component of our program. In this area we have determined that only an informed public and educated citizenry is capable of creating the climate for effective noise control at both the State and local levels. In this regard, we have worked with nationally represented organizations such as the National Retired Teachers Association/American Association of Retired Persons, the National Urban League, the National League of Cities and others to help us with the process of educating and mobilizing community and neighborhood based organizations for the purpose of organizing effective measures to reduce excessive noise. Through a cooperative relationship with two of these organizations, we have established the Community Noise Counselor program designed to accomplish this goal. In other places we have utilized the services of senior citizens to assist with the development and implementation of State and local programs. We have even placed older Americans in host positions in our Regional Offices to work there in support of the Regional Programs. We have initiated a Quiet School Program and developed curricula for the elementary and secondary school levels which are designed to create behavioral and attitudinal changes in students with respect to noise. In short, we are creating an awareness ethic among students that will spill over into their homes and that will serve them well in later life.

SUMMARY

In short, I believe that we have used our program and financial resources wisely. We have tried to capture the maximum benefit from our grants and cooperative agreements with States so that they will assume their rightful role in the process of noise control. The bulk of that role is to work with local communities and help them solve their noise issues and problems. We have also tried to capitalize on the talents and time of volunteer organizations and individuals to the maximum possible extent in generating effective local programs.

When broken down, the national noise control and abatement program is, to a large extent, a manpower and training program. Since EPA will never have the resources to adequately address all of the personnel and educational requirements presented by the goals of the noise program, it is incumbent on us to recognize the capacity of the established organizations and programs to assist

us in that effort. Once we have initiated the delivery of services through these institutions and programs, we need to concentrate on the development of State and local capacities and capabilities to deal with their own noise problems and issues. In so doing, we will be institutionalizing noise programs at the appropriate levels of government.

There is, of course, much to do before we reach our goals of reducing the excessive environmental noise levels in our nation's cities. Unlike many environmental programs, we do not need huge sums of money to make substantial progress. Our program enjoys one of the highest public acceptance levels of all EPA programs. People impacted by excessive noise want to do something about it—they just need to be advised as to what the remedies are. During the next four years we intend to capitalize on this public concern to bring about positive and constructive action in our nation's neighborhoods and communities. With this level of support, I am confident that we will find the people to carry out noise abatement and control programs at all levels of government.

An Overview of Environmental Health Practices — Roles, Functions, and Credentialing

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INTRODUCTION

There is no other career category in the field of environmental health that has taken a more comprehensive approach to identifying and restructuring its profession based on practice as a sanitarian. Since the sanitarian is a generalist at entry level and much of the work leading toward the national credentialing mechanism established by the National Environmental Health Association (N.E.H.A.) focuses on the professional sanitarian, it is fitting that this overview be limited solely to the sanitarian as a model of the stepwise credentialing process. Other career categories in the field of environmental health such as a sanitary engineer, soil scientist, and others, could just as easily be used in this paper to identify the roles and functions which lead to a different credentialing process. Also, since the membership of the N.E.H.A. is composed of many career categories, any number of careers could have been selected. The entire credentialing process for sanitarians as developed by N.E.H.A. is a stepwise process comprising five phases:

- Role Delineation and Verification
- Educational identification — development of the knowledge, skills, and attributes plus a curriculum guide
- Self-Assessment Tools
- Continuing Education Modules
- The Credentialing Examination

By completing the five phases, the sanitarian will achieve professional status in the field of environmental health, especially since his or her practice is now clearly identifiable. Never before has an environmental health profession been able to pull together all the aspects of its profession into one modern, stepwise process.

Role Delineation and Verification

In July, 1975, the Bureau of Health Manpower, Health, Education and Welfare awarded a contract to the N.E.H.A. to select a career category within the field of environmental health and develop a role delineation model. The model was to be developed through a detailed task analysis study and expert opinion. Fourteen program areas in which the sanitarian practiced were identified. Approximately 2,000 tasks performed by the sanitarian were rated as to frequency of practice. Only those tasks performed most frequently throughout the U.S. were kept as major sanitarian activities (responsibilities), and the others were easily broken down into specific activities (responsibilities without the major one). Once the sanitarian activities were arranged in order of complexity, experts from the field were asked to determine levels among the activities (responsibilities). Three position levels (positions 1-3) were determined with the highest position, #3, divided into an administrative level and a scientist level (position 3A and 3B):

1. Position #1
2. Position #2
3. Position #3A - Administrative
Position #3B - Technical Scientist

Functions are designated by key action words used in pinpointing the activities. The level #1 practitioner performs the following activities: 1. inspects 2. field samples 3. tests 4. enforces, and 5. delivers public information. These functions convert into the following major responsibilities:

- I. Conducts routine environmental health inspections
- II. Authorizes issuance of permits and licenses
- III. Collects samples and specimens for laboratory analysis
- IV. Performs routine field tests
- V. Communicates environmental health information to others
- VI. Plans and implements environmental health investigations
- VII. Reviews and evaluates documents, licensure applications and planning specifications
- VIII. Represents department favorably to the public
- IX. Works productively with other staff members

Please keep in mind that position level #1 has many specific responsibilities listed under each of the nine major responsibilities. This is also true for each of the other position levels.

People performing position work at level #2 are expected to do the following functions: 1. educate 2. investigate 3. consult 4. enforce, and 5. plan programs and activities. In other words, the practitioners perform the following responsibilities:

- I. Communicates environmental health information to others
- II. Organizes environmental health investigations

- III. Provides consultative services relating to environmental health problems
- IV. Conducts routine environmental health inspections
- V. Supervises staff activities
- VI. Participates in the planning and development of environmental health program activities
- VII. Reviews and evaluates documents, licensure applications and planning specifications
- VIII. Represents department favorably to the public
- IX. Serves as official representative of agency
- X. Works productively with other staff

As one can see, overlap of activities occur between position levels. This overlap also occurs in the actual on-the-job situation which builds flexibility into the job positions. Unless this overlap is identified by the top administrator, a person could be caught in a situation whereby upward job mobility could repeat past work instead of introducing the professional to new job skills.

Finally, the third position level, Administrative arm, performs the following functions: 1. supervision 2. administrative and planning activities 3. directs enforcements, and 4. directs investigations. The actual major responsibilities he or she would be entrusted with would be:

- I. Participates in planning and development of environmental health program activities.
- II. Reviews and evaluates documents, licensure applications, and planning specifications.
- III. Conducts liaison activities with other agencies and groups.
- IV. Plans and directs environmental health programs.
- V. Oversees enforcement proceedings in connection with health violations.
- VI. Supervises staff activities
- VII. Communicates environmental health information to others.
- VII. Organizes environmental health investigations.
- IX. Provides consultative services relating to environmental health problems.
- X. Represents department favorably to the public.
- XI. Conducts meetings and conferences.
- XII. Serves as official representative of agency.

The other position #3 type of person is the Technical Scientist who is usually located in an academic setting. That person may begin his or her career at entry level, but the professional almost always specializes in one or a few program areas. A person practicing in this position does not remain at entry level, but moves to advanced level

quickly. The practitioner performs the following functions: 1. directs educational programs 2. directs investigative programs 3. consults with industry and governmental agencies 4. administers in environmental management. These people have the following major responsibilities:

- I. Organizes environmental health investigations
- II. Provides consultation services relating to environmental health problems
- III. Participates in planning and development of environmental health problems
- IV. Plans, and directs environmental health programs
- V. Conducts liaison activities with other agencies and groups
- VI. Communicates environmental health information to others

Each of the activities cited for the three position levels were verified by involved practitioners in a series of workshops held throughout the U.S. Through these workshops, the Role Delineation Model was refined until it reflected the current state-of-the-art. These, then, are the activities performed by today's sanitarians (the Role Delineation Model).

K.S.A. and Curriculum Guideline Development

In order to perform sanitarian tasks, the sanitarian needs an educational framework — Knowledge, Skills and Attributes (K.S.A.s). The N.E.H.A. was awarded another contract by H.E.W.'s Bureau of Health Manpower to determine the competencies and abilities needed for practice. In order to clearly identify those K.S.A.'s the N.E.H.A. researched the practice and discovered five knowledge "building blocks," or foundations of practice. Those building blocks are:

1. Knowledge of disease and injury causation and control techniques.
2. Knowledge of administrative law and process.
3. Knowledge of the utilization of resources in the collection, arrangement and interpretation of data.
4. Knowledge of environmental health administration.
5. Knowledge of the behavioral sciences.

An N.E.H.A. document entitled "The Sanitarian in Environmental Health: Responsibilities and Competencies," gives the complete outline of those knowledges and skills required for the sanitarian to be competent in his/her practice. The basic knowledges and skills are most easily acquired through completion of a bachelor's degree in the environmental health sciences. Those competencies (knowledges and skills) have been included in a curriculum guideline which is a valuable tool for employers in governmental,

industrial and academic settings. In other words, trainers and educators involved in the competency instruction of sanitarians will find the resource document entitled, "Curriculum Guideline for Environmental Health," (produced under a contract from H.E.W., Bureau of Health Manpower by N.E.H.A.) contains the teaching strategies (based on knowledge, skills and attributes) necessary to implement an environmental health curriculum. The details are contained in each document.

Self-Assessment Tools

Once the framework of knowledge for the sanitarian at entry level had been identified, the next step was to uncover the practitioner's proficiencies and deficiencies. This search is currently being carried out nationally by the National Environmental Health Association through a contract by the Department of Health and Human Services. The statistical data collected from this study will enable the researchers to develop self-contained learning modules around the knowledges and program areas of greatest need. The Self-Assessment Tools, the Role Delineation and learning modules will have to be updated periodically to keep up with the constant changes in the field. The N.E.H.A. is dedicated to keeping the practitioners competent.

Self-Learning Modules

The University of Washington School of Public Health is developing a series of regional environmental health self-paced learning modules based on the five knowledge categories for the Pacific Northwest. At the same time, the N.E.H.A. has begun to develop additional self-learning modules which can supplement those being developed by the University of Washington. Duplication has been eliminated; therefore, the subject coverage has been greatly enhanced. This coordinated effort for sanitarians has been made possible by the Bureau of Health Manpower, H.H.S., which contracted both organizations to complement efforts on behalf of the sanitarian.

Credentialing Examination

For many years the Professional Examination Service (P.E.S.) has developed and updated a national norm-referenced examination for sanitarians. It was appropriate for P.E.S. to be awarded a contract to develop a criterion-referenced exam based on the Role Delineation Model and which would eventually become the national credentialing examination. All associations having sanitarians in their membership have assisted P.E.S. in developing the criterion-referenced exam; therefore, the exam truly represents professional

practitioner input regardless of association affiliation. Presently, 33 states have Sanitarian Registration Acts and most utilize a form of the current P.E.S. norm-referenced examination. Once the criterion-referenced examination is complete, states will be encouraged through the various professional associations, to utilize the New P.E.S. credentialing examination.

Professionals known as sanitarians are demanding one very important and fundamental quality of themselves and peers; that the practitioner be educated and be updated periodically (be competent in practice). With this quality, the sanitarian not only identifies himself or herself as a professional but is able to stand shoulder-to-shoulder with fellow workers within the field of environmental health.

Preparation for Practice in Environmental Health at the Graduate Level

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INTRODUCTION

In many regards, the leadership for environmental training has been in departments of engineering, biology, chemistry and environmental sciences, whose graduates generally do not identify their activities with public health. This is suggested by the recent Bureau of Health Manpower Development estimate that no more than 25,000 of the present 135,000 professionals involved in environmental protection (including pollution control) have primary functions directed toward improving health. While data on the educational backgrounds of these graduates is not well defined, information available for the Schools of Public Health in academic, 1974-1975, suggest that the majority of graduates in environmental health were specializing in water pollution (approximately 53% of masters' degree candidates) with lesser proportions in air pollution (12%) and occupational health (11%).¹

It is apparent, however, that the study of applied toxicology is an increasingly important element in the specialties that make up environmental health. The latter is reflected in the knowledge, skill and educational backgrounds which are needed for competency in the field.^{2,3} As a result, most programs attempt to insure that their graduates will have basic knowledge in toxicology as well as specific skills in chemical analysis and environmental monitoring.

The Educational Perspective

It may be useful, at this point, to further develop the

perspective on environmental health, both as an area of professional practice and in respect to its present relationship with environmental protection.

First, environmental health is concerned less with environmental protection than with the reduction of human disease and suffering by manipulation of man's environment. To accomplish this, the field draws on a number of areas including both the basic and applied sciences, engineering, administration and law and the result that practitioners in environmental health are often expected to apply broad areas of knowledge to solutions of specific problems. The extent to which this expectation exists is illustrated by the learning objectives of the newer (1978) graduate programs in environmental health, whose graduates:

... are expected to develop skills in recognizing, evaluating and controlling environmental insult within the general environment, and specifically are expected to be able to integrate their basic and applied science training with problems involving the transport, distribution and persistence of chemicals in the environment, understand the basic elements involved in accumulation of chemical residues, *have knowledge of potential mechanisms of action of chemical and microbial agents*, be able to carry out chemical and biological assays, and have a general understanding of *the epidemiological aspects and consequences of environmental contamination*.^{4, 5}

It is also expected in most environmental health programs that graduates should be able to develop strategies to organize and deliver environmental health services and have a good understanding of the practical problems of environmental sampling and analysis. As a result, environmental health overlaps with the field of environmental protection in the approaches used to develop information on the toxicity, transport, distribution and fate of biologically active agents in the environment (see Figure 1). There remains, however, some distinction in the use to which the two fields put their common data which—at times is admittedly blurred—but probably strong enough to warrant continued separation of the two fields of study.

Characteristics of Programs in Environmental Health

Data collected in a recent review of the self-study documents of ten Schools of Public Health suggests that there have been substantial changes in the direction of program development

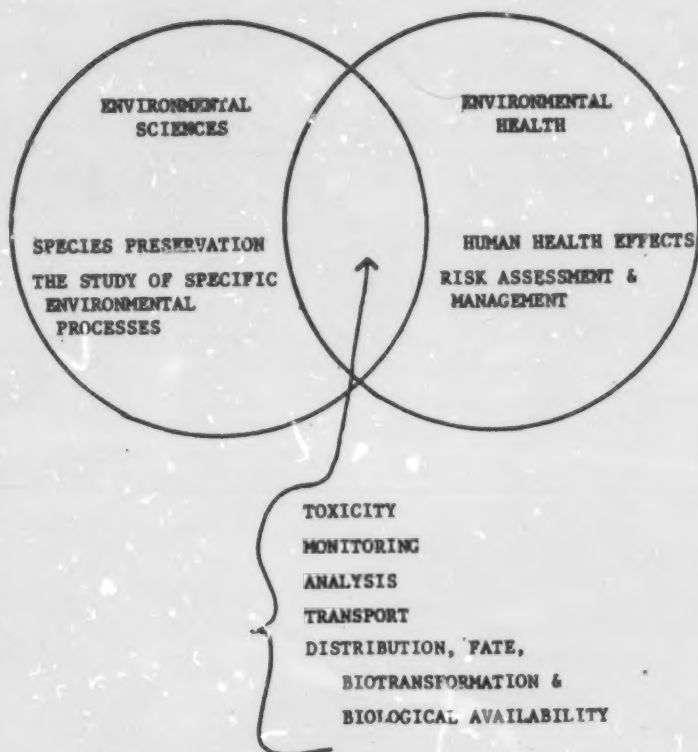


Figure 1. Overlap in the Areas of Environmental Health & Environmental Science

in environmental health since the period 1974-1975 (4-13).*

While this is in no way a comprehensive review of academic programs in environmental health (representing less than one-half of the existing programs) it is interesting to note the expansion in certain areas.² These are shown in the programmatic areas of Table 1 for which 40% or more of the schools

*In an attempt to define the changing nature of programs in environmental health, ten schools were selected which had completed the self study phase of accreditation by the Council for Education in Public Health (CEPH) during the years 1976-1981.4-13. Schools selected varied considerably in size and age and include both public and private institutions. The accreditation process is normally performed over a five-year cycle, and involves an on-going self-study process by which the individual schools delineate their perceived strengths and weaknesses.

reviewed had academic programs in the areas of: environmental administration, management or protection; general environmental health; occupational health engineering, occupational health science, occupational health; *toxicology or environmental toxicology*; radiation health science, radiation health or radiological hygiene; industrial hygiene; water resources engineering, water quality, water quality management; and air quality or air quality management. These basic programs are accompanied by diverse, but substantial, academic efforts in the areas of: community health, food protection, noise control, pesticide protection, occupational medicine, environmental physiology, safety and environmental safety, general environmental sciences, environmental

Table 1: Characteristics of Environmental Health Programs in Ten Selected Schools of Public Health

<u>PROGRAM AREA</u>	<u>NUMBER OF PROGRAMS</u>
ENVIRONMENTAL ADMINISTRATION/ MANAGEMENT/PROTECTION	5
ENVIRONMENTAL HEALTH (GENERAL)	5
OCCUPATIONAL HEALTH ENGINEERING OCCUPATIONAL HEALTH SCIENCES OCCUPATIONAL HEALTH	5
TOXICOLOGY OR ENVIRONMENTAL TOXICOLOGY	5
RADIATION HEALTH SCIENCE, RADIATION HEALTH OR RADIOLOGICAL HYGIENE	4
INDUSTRIAL HYGIENE	4
WATER RESOURCES ENGINEERING, WATER QUALITY OR WATER QUALITY MANAGEMENT	4
AIR QUALITY OR AIR QUALITY MANAGEMENT	4
	<u>36/52</u>

SOURCE: SELF-STUDY DOCUMENTATION FOR ACCREDITATION
BY THE COUNCIL ON EDUCATION IN PUBLIC HEALTH,
1976 - 1981

Table 2: Characteristics of Environmental Health Programs in Ten Selected Schools of Public Health

<u>PROGRAM AREA</u>	<u>NUMBER OF PROGRAMS</u>
COMMUNITY HEALTH, FOOD, NOISE, PESTICIDES	3
OCCUPATIONAL MEDICINE	3
ENVIRONMENTAL PHYSIOLOGY	2
SAFETY & ENVIRONMENTAL SAFETY	2
ENVIRONMENTAL SCIENCES (GENERAL)	1
ENVIRONMENTAL CHEMISTRY	1
ENVIRONMENTAL BIOLOGY	1
LAND, ENERGY AND NATURAL RESOURCES	1
ENVIRONMENTAL ENGINEERING	1
OCCUPATIONAL HEALTH NURSING	1
	16/52

SOURCE: SELF-STUDY DOCUMENTATION FOR ACCREDITATION
BY THE COUNCIL ON EDUCATION IN PUBLIC HEALTH
1976 - 1981

chemistry, environmental biology, land, energy and natural resources, environmental engineering, and, in one case, occupational health nursing (see Table 2).

The program areas defined here are also accompanied by a number of specialties (and subspecialties) which include environmental microbiology; environmental toxicology; mammalian toxicology; specific areas of toxicology including mutageneses, teratogeneses, carcinogenesis, aquatic toxicology, focusing on biological accumulation, water and waste water treatment, air pollution studies, environmental planning, land use planning, physiology, and environmental physiology; environmental epidemiology; control of hazardous

chemicals; acoustical environmental control; and meteorology. If not formidable, the list at least suggests that considerable breadth and diversity exist with currently available programs! (Table 3)

Table 3: Characteristics of Environmental Health Programs in Ten Selected Schools of Public Health

SPECIALTIES & SUBSPECIALTIES WITHIN EXISTING PROGRAMMATIC AREAS

ENVIRONMENTAL HEALTH MICROBIOLOGY	2
ENVIRONMENTAL HEALTH TOXICOLOGY	1
TOXICOLOGY	3
TOXICOLOGY OF CARCINOGENS	1
WATER & WASTE WATER TREATMENT	1
AIR POLLUTION	1
AQUATIC TOXICOLOGY (BIOLOGICAL ACCUMULATION)	1
ENVIRONMENTAL PLANNING	1
LAND USE PLANNING	1
PHYSIOLOGY	1
ENVIRONMENTAL EPIDEMIOLOGY	1
CONTROL OF HAZARDOUS CHEMICALS	1
ACOUSTIC ENVIRONMENTAL CONTROL	1
METEOROLOGY	2

SOURCE: SELF-STUDY DOCUMENTATION FOR ACCREDITATION
BY THE COUNCIL ON EDUCATION IN PUBLIC HEALTH

A similar degree of diversity also occurs in program direction and extent to which the several programs are involved in research or on the preparation of researchers and academic personnel. To some extent both research and research training follow faculty resources with the larger, and generally older schools, focusing on the production of researchers and academicians.

Of the ten schools reviewed for this meeting, only four had environmental program faculties less than ten, while three had faculties between 11 and 20, two between 21 and 30, and one a combined environmental faculty of 59 (see Table 4).

Student enrollment was found to follow a somewhat similar distribution, ranging from a minimum enrollment category of

Table 4: Characteristics of Environmental Health Programs in Ten Selected Schools of Public Health.

<u>*FACULTY STRENGTH, FTE'S</u>	<u>NUMBER OF PROGRAMS</u>
1 - 10	4
11 - 20	3
21 - 30	2
31 - 40	-
41 - 50	-
51 - 60	1
 <u>*STUDENT ENROLLMENT, FTE'S</u>	
1 - 10	-
11 - 20	4
21 - 30	1
31 - 40	-
41 - 50	2***
51 - 60	1
61 - 70	-
71 - 80	1
100	1 (156)

SOURCE: SELF-STUDY DOCUMENTATION FOR ACCREDITATION
BY THE COUNCIL ON EDUCATION IN PUBLIC HEALTH

* AT YEAR OF SELF-STUDY REPORT, INCLUDES RESEARCH APPOINTMENTS
BUT NOT CLINICAL OR ADJUNCT APPOINTMENTS

** INCLUDES BOTH DOCTORAL & MASTERS' STUDENTS FOR YEAR OF SELF
STUDY REPORT, AS FTE'S

*** INCLUDES ONE SCHOOL WITH RELATED DEPARTMENTS

11 to a high of 156. In general, it was observed that the more extensive faculties were accompanied by larger student bodies but, in several institutions, the preponderance of students in doctoral programs produced a student/faculty ratio approaching one. Unfortunately, the reporting of student enrollment in the self-study process is so summarized that estimates of enrollment in specific program specialties and subspecialties is not possible—nor is it possible to gain data on the distribution of masters' and doctoral enrollment in every school.

Part of the program diversity among the schools is also reflected in the nature of the degrees awarded at completion of a study (see Table 5). The most common degree awarded by environmental programs is the Masters' of Public Health (MPH, 9), followed closely by the Master of Science (MS, 5), and somewhat more distantly by the Master of Science in Public Health (MSPH, 2). Other schools, for largely historical reasons, award the Master of Health Science (MHS) or Master of Science in Environmental Hygiene (MS(Hyg)). The degree of Master of Science in Environmental Engineering (MSEE) is awarded by one accredited program in engineering, residing in one of the Schools of Public Health.⁹ Doctoral degrees, in

Table 5: Characteristics of Environmental Health Programs in Ten Selected Schools of Public Health

<u>DEGREE</u>	<u>NO. OF SCHOOLS ADOPTING²</u>
<u>MASTERS</u>	
M.P.H.	9
M.S.	5
M.S.P.H.	2
M.H.S.	1
M.S.E.E.	1
M.S. (HYG.)	1
SC.M.	1
<u>DOCTORAL</u>	
Ph.D.	8
DR.P.H.	7
SC.D.	1
D.SC. (HYG.)	1

SOURCE: SELF-STUDY DOCUMENTATION FOR ACCREDITATION
BY THE COUNCIL ON EDUCATION IN PUBLIC HEALTH
1976 - 1981

¹ AT DATE OF SELF-STUDY REPORT TO THE COUNCIL ON EDUCATION FOR PUBLIC HEALTH

² INDIVIDUAL SCHOOLS MAY GRANT AS MANY AS FIVE SEPARATE DEGREES IN THE FIELD

order of granting preference, included the Doctor of Philosophy degree (Ph.D., unspecified), followed by the Doctor of Public Health degree (Dr PH), the Doctor of Science degree (ScD), and the Doctor of Science in Hygiene degree (DSc(Hyg)).

Within this framework, considerable overlap exists among programs for which the same degree may be awarded, as do differences in requirements for the several degrees between the schools granting common degrees. There does, however, appear to be some consensus for awarding the MPH at the completion of shorter term programs, and to persons with prior work experience in public health. To some extent, the same is also true in the granting of doctoral degrees, although the DrPH often receives special recognition as a professional degree, intended for practitioners.

The data presented thus far might suggest that there is little unanimity among the programs of environmental health offered in graduate Schools of Public Health. While this is true in terms of diversity, it does not appear to be as much the case with program content and delivery.

Educational Strategies

The basic strategy which has evolved, though not uniformly accepted, is to divide instruction between the areas of a comprehensive didactic core and course work or experience specific to the student's area of specialization (see Table 6). The principal argument for this architecture appears to lie in the need to impart a solid conceptual base or bases on which the graduates' future efforts at problem recognition and evaluation can be built, with minimal risk of failure to society. For the generalist, core content was found to focus heavily on the life sciences of physiology, biochemistry and microbiology, as well as the sciences of chemistry and radiation physics. Taken together with toxicology and the applied sciences of epidemiology and biostatistics, these areas are thought to be especially important to the future practitioner—as a base from which he can, with experience, evaluate and, hopefully, control new problems as they emerge. That there has been a national need for such skills is immediately evident from our recent experience with a number of diverse agents. Thus, the core curriculum is usually approached with considerable rigor.

The extent to which the core may be offset by specialty course content appears to depend on the entering student's qualifications, career objectives and expected job function; especially in the areas of radiological health, environmental

Table 6: Organization of an EHS Core by Level of Professional Skill and Responsibility

RECOGNITION	EVALUATION	CONTROL
BIostatISTICS	BIostatISTICS	ENVIRONMENTAL MANAGEMENT
INTRODUCTORY EPIDEMIOLOGY	INTRODUCTION TO ECOTOXICOLOGY	PUBLIC HEALTH LAW
PRINCIPLES OF ENVIRONMENTAL HEALTH	ENVIRONMENTAL MICROBIOLOGY	SEMINAR
APPLIED HUMAN PHYSIOLOGY	ENVIRONMENTAL CHEMISTRY I	
ENVIRONMENTAL CHEMISTRY II: BIOCHEMICAL APPLICA- TIONS IN ENVIRONMENTAL HEALTH	EPIDEMIOLOGY OF CHRONIC DISEASES	
	RADIOLOGICAL HEALTH	

chemistry and industry hygiene—which are generally structured to provide depth rather than breadth in their curricula. Further, there is some evidence that overall program emphasis is shifted from control to recognition and evaluation for students seeking careers in government; while course content for students oriented toward industry is often directed to engineering control.

In the water quality curriculum shown in Table 7 the evaluative stage includes the development of skills associated with sampling of environmental media as well as specialized skills in aquatic toxicology, e.g., in contaminant accumulation and field sampling. Similarly, in a water quality program, control efforts can be directed towards regulation strategies as well as treatment methods and the specific knowledge and skills needed for design and operation of those processes.

It may be debatable that the material in ecotoxicology (Table 6), due to its pervasive nature, might more appropriately be delivered in the specialties by dividing course content into its component parts. Indeed, it is possible to build programmatic areas incorporating a hierarchy of skill development without the use of a comprehensive core. However, such programs often exert larger demands on faculty time or are

deliberately structured to produce a higher degree of specialization. In point of fact, the most common basis for the decision to develop in one direction or the other seems to be dictated by the resources available to the program, the objectives of its faculty and their perspectives on the trade-off of a broad education against depth in an individual specialty.

Table 7: Specialty Organization by Level of Professional Skill and Responsibility: Water Quality

RECOGNITION	EVALUATION	CONTROL
	FIELD SAMPLING METHODS	POTABLE WATER TREATMENT
	AQUATIC TOXICOLOGY: BIOCONCENTRATION LABORATORY	BIOLOGICAL WASTE TREATMENT
	DIRECTED RESEARCH	UNIT OPERATIONS
	DIRECTED RESEARCH	DIRECTED RESEARCH

Discussion

The problem faced by educators in environmental health is characterized by the need to produce highly skilled individuals for employment in a complex and rapidly developing field. As such, the solutions are diverse but limited to producing generalists capable of a limited response to a wide variety of environmental problems, or specialists whose area of expertise may be limited but whose capacity to intervene is great. This has produced a particularly intriguing problem not yet answered. As a rule, when one thinks of educating specialists, the normal progression is from general studies to the specialty. However, the economics of the times suggest that this may not be the appropriate model for environmental health, and that it is, indeed, a generalist, with more training than the current norm, who is most urgently needed to cope with the problems which will face state and local health agencies in the next decade. If this is true, then there is a need for those individuals presently involved with the practice and the teaching of the profession to develop a format by which an appropriate educational response can be made. I am pleased to say that such efforts have already begun under the sponsorship of the Bureau

of Health Manpower Development and the University of Minnesota, which held its first workshop last September¹⁴. Further, one would hope that with the help of the governmental agencies involved in this program that a mechanism can be established—both to insure continuation of this effort and to facilitate rational health manpower development over the next decade.

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Preparation for Environmental Health Practice—Undergraduate Level

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INTRODUCTION

The task of preparing undergraduate environmental health education programs is subject to many influences and pressures ranging from the demands of the employment sector to credentialling systems entailing program accreditation and professional licensure and certification. It is a process in which the curriculum becomes a product of consensus rather than a finite educational formula.

Environmental health is a complex and all-encompassing field of practice that is both an art and a science. It encompasses those knowledges and skill which are essential to the management and control of all forms of life, substances, forces, and conditions in the surroundings of man that may exert an influence on human health. Any student aspiring to become an environmental health practitioner must develop the competencies required to maintain an optimum balance between two rather complex environments—the societal environment of man and all the driving forces which it encompasses and the natural environmental systems which support human life and which are impacted upon by societal actions.

While natural and societal environments command the attention and concern of a wide range of professional and technical disciplines, it is the environmental health professional who represents the general practitioner in this area of health-related services. Environmental health practitioners, or sanitarians as the general practitioners are commonly called, occupy the same relationship as physicians represent in the

practice of medicine. They are the health manpower unit around which environmental health services are structured. They reflect a profession having roots deep within the practice of preventive medicine, particularly as it relates to environmental stresses upon the general physical, mental, and social well-being of man.

Any undergraduate curriculum in environmental health must concentrate upon human ecological relationships. Sciences and technologies essential to the establishment and maintenance of desired levels of compatibility between human activities and natural environments are cornerstones in curriculum design. The curriculum, in addition, must provide for development of the knowledges and skills required to influence and manage the societal responses and changes required to maintain a reasonably balanced human environment. The ability to link environmental stresses to human health and to effectively identify and carry out preventive and remedial measures is the trademark of the successful environmental health practitioner and the basic goal of any responsible undergraduate program in this field of career education.

Curriculum Influences

Educational programs tend to reflect the character and complexity of the institutional setting. Accredited environmental health degree programs tend to develop within colleges and universities having a commitment to the preparation of other health-related professionals. These settings generally offer the range of science, behavioral science, communication studies and supportive health-related courses which are fundamental to the development of strong programs of study in environmental health technologies and the practicum experiences which are essential for job-readiness in the graduates.

Credentialing systems exert a major influence upon the scope and content of the curriculum. Professional registration requirements generally include specific educational criteria, which in turn influence the nature, if not the existence, of any undergraduate environmental health program. Currently, twenty-eight states have professional registration laws for Sanitarians and the National Environmental Health Association maintains a national voluntary registration program through its headquarters in Denver. Twenty-seven of the states, as well as the National Environmental Health Association, have established a baccalaureate degree as a minimum

education requirement. Part of the process of registration requires successful completion of a national professional registration examination covering a wide range of competencies expected of entry-level professionals. Any educational program proposing to prepare environmental health professionals is guided in curriculum development by the scope of proficiencies covered in the national credentialing examinations.

The examinations, which are prepared for most registration boards by the Professional Examination Service in New York, are based upon proficiency criteria for environmental health personnel which have been established by the national role delineation studies conducted by the National Environmental Health Association for the U.S. Public Health Service Bureau of Health Manpower. These studies and reports identified the roles and functions of the generalists in the field of environmental health who are traditionally referred to as Sanitarians. The surveys covered personnel working in federal, state and local governmental settings, as well as in private industry, and covered the assessment of knowledges, skills, and attributes essential for proficiency at various levels in the practice of environmental health. These studies are of great value in the development of proficiency examinations and the modification and expansion of manpower training programs.

Of significant influence on undergraduate programs in environmental health are the guidelines for accreditation developed by the National Accreditation Council for Environmental Health Curricula. The accreditation program grew out of a series of national conferences and workshops relating to the education of environmental health personnel which were sponsored by the National Environmental Health Association, the U.S. Public Health Service, the National Sanitation Foundation, W.K. Kellogg Foundation and others during the late fifties and sixties. These conferences produced guidelines for the education of environmental health personnel at the associate and baccalaureate degree levels which were adopted by the National Accreditation Council when it was organized in 1968. East Tennessee State University was the first program to be accredited in 1969, and by 1980 eighteen colleges and universities had qualified for accreditation under the national program.

In addition to these accredited schools, there are 106 colleges and universities which have been identified by an American Society of Allied Health Professions survey as having programs for preparing environmentalists, a generic term which

Table 1

	<u>Degrees Offered</u>
California State University, Fresno	B.S.
California State University, Northridge	B.S., Graduate
Colorado State University	B.S., Graduate
East Carolina University	B.S.
East Central Oklahoma State University	B.S.
East Tennessee State University	B.S., Graduate
Ferris State College, Michigan	A.A.S., B.S.
Hunter College, CUNY, New York	B.S.
Illinois State University	B.S.
Indiana State University	B.S.
Montana State University	B.S.
Mississippi Valley State University	B.S.
Oregon State University (Provisional)	B.S.
University of Massachusetts, Amherst	B.S.
University of Washington	B.S.
University of Wisconsin, Eau Claire	B.S.
Wright State University, Ohio	B.S.

includes sanitarians. In addition, there were 55 colleges and universities which offered baccalaureate degree programs preparing environmental engineers. In addition, the survey reports 32 programs preparing environmental health technicians and 6 which prepare environmental engineering assistants. These don't include the number of specialized undergraduate programs for industrial hygienists, water and wastewater technologists, air pollution technologists and radiological health technologists, among others. Because of the complexity of such an array of environmental health educational programs, this paper will address the scope and character of programs for preparing environmental health generalists, those for which the accreditation process provides guidelines.

Basic Educational Requirements

Any education program and curriculum tends to reflect the philosophy, resources, and basic educational structure unique to each institutional setting. The curricula must be structured with dialogue between environmental health practitioners and the institution to assure the inclusion of those competencies in demand in the manpower market served by the school. It is impossible to achieve the desired level of competency required in all health-related areas of environmental concern, so each program must strive to incorporate those studies required to develop entry-level competencies having highest priority in the educational service area. Expanded and specialized expertise can then be developed through advanced training and education.

An example can be drawn from a brief overview of the B.S. degree curriculum at Ferris State College. In addition to the general health-related courses noted above, all environmental health students are required to take a core of environmentally related subjects which include Environmental Health Practice, Water Supply and Pollution Control, Shelter Environment, Environmental Health Management and Environmental Health Laboratory. Students then can select from a matrix of optional courses of study in the areas of General Environmental Health, Vector Control or Environmental Planning and Management. In these optional programs of study, they will cover additional courses in Air Pollution, Food Technology, Solid Waste Management, Vector Control, Noise Control, and others in the area of environmental health technology. The graduate is expected to complete 90 of the required 186 quarter hours in general health and environmental health-related studies. Programs in other schools may vary in the scope and mix of courses of study, but all accredited programs stress the general range of environmental health competencies in the graduate.

The major enigma in structuring vocational and occupationally centered education is the task of blending the theoretical and practical training needed for employment. The pace of scientific and technological change, together with increasing specialization, pose constant challenge for competency-based educational programming. Maintaining relevancy with the market place is a major area of concern in manpower development in the health professions and environmental health is no exception. The need for job readiness in any vocational educational program is a basic tenant which

is particularly emphasized in the accredited environmental health curricula. Field training or internships constitute an essential criteria for the preparation of the practitioner. Field training should be of a comprehensive nature and of a duration sufficient to permit the student to build a sound linkage between the theory of the classroom and laboratory and the realities of the field practice.

At Ferris State College students gain this practical experience through a ten week internship, an additional summer environmental management field studies program and the routine involvement of student in ongoing campus environmental surveillance programs. The latter includes the operation of an air monitoring station, campus occupational safety and health surveillance and vector control. The summer management studies program is especially unique because it combines studies in Environmental Management, Environmental Assessment and Impact Analysis, Environmental Conservation, Environmental Engineering and Cultural Geography in a practical field study setting. Seminars and lectures are combined with field laboratory and survey activities designed around a real life community project. Students carry out all facets of the survey including the surveying, mapping, photography, laboratory studies and production of a final published report for public distribution.

The structuring of two year and four year curricula should anticipate the progressive career goals that are common to environmental health practitioners at both the technical and professional levels. Schools are encouraged to provide sufficient curriculum flexibility to allow the upward mobility of students from lower to higher degree levels without a significant loss of academic credit. Environmental health, as with most health-related professions, places heavy emphasis upon progressive career development and continuing education. Credentialing mechanisms reflect this philosophy, and educational programs which provide sound patterns for articulation from technician to professional level degrees are encouraged.

Undergraduate programs are interested in developing professional attributes in their student to balance the knowledges and skills students are expected to gain from the curricula. Most schools encourage the organization of student pre-professional groups under affiliated relationships with state and national environmental health associations. Student organizations are encouraged by their sponsors to engage in community and collegiate activities which reflect desirable

levels of professional concern and responsibility, and each year the outstanding student affiliate is nationally honored by the National Environmental Health Association. In addition, Epsilon Nu Eta has recently been organized as a national honor fraternity for environmental health students, thus providing an added educational stimulus to further accentuate the educational emphasis upon the development of professional attributes prior to entering the field of practice.

Non-Traditional Educational Programming

There has been growing concern for the future of the large pool of technical personnel currently employed in environmental health positions as non-degreed working environmentalists or sanitarian technicians. Many began their careers in environmental health when requirements for a baccalaureate degree were either non-existent or remotely applicable. Today these individuals find themselves in a credentialing crunch which demands that professionals in general, and environmental health professionals in particular, have their competencies validated through degree requirements, certification and continuing education. Laws which now require that environmental health professionals be degreed and registered to protect the public good, as well as personnel policies which establish employment educational criteria for career advancement, place the non-degreed environmentalists and sanitarian technicians at a disadvantage and in a state of frustration.

Under a special project grant from the Bureau of Health Manpower, U.S. Public Health Service, Ferris State College has been developing an externalized degree program to meet the needs of working environmental health personnel who for various reasons cannot leave their position, disrupt family life or abandon community commitments in order to achieve the required professional degrees. Thus, they are unable to advance themselves in traditional patterns of post-secondary education. The external degree project is designed to positively address a very real problem in the retention and conservation of these existing environmental health manpower resources. The project is in the final year of development of a demonstration model environmental health external degree program which hopefully will find broader acceptance and utilization in other educational settings.

The protocol for the external degree model is designed to assure the development of the same general range and level of competencies expected of individuals graduating from the

campus-based traditional environmental health programs. The external degree program consists of two general operational phases:

A. Assessment—Entry to the External Degree Program is usually gained through an assessment phase which endeavors to comprehensively evaluate all related knowledges and skills which have been gained through practical experience, in-service training and other learning as a result of life/work experiences. Appropriate college credit is awarded for related learning which can be identified and academically substantiated.

B. Instruction—A committee of academic advisors work with each student in the development of a prescriptive curriculum of study which builds upon the assessment findings and which through a combination of traditional and non-traditional education processes, will develop the knowledges, skills and attributes expected of an entry-level sanitarian. The instructional process utilizes methodology and strategies which do not require the external student to take extended leave of absence from the job, home or community responsibilities.

This program is proving attractive to members of the armed forces who already have received excellent technical training and experience on duty and who wish to enter civilian environmental health employment upon discharge or retirement from the service. The external degree opportunity also has attracted a wide range of students across the nation who are currently employed as environmental health technicians in government and industry. It is interesting to note that the rigors of independent study and self direction in this educational model are quite demanding, and several students who initially embarked upon the external degree program have since found ways to transfer to the campus-based programs and hasten the completion of their degree.

In a rather unique and progressive inter-institutional arrangement, Ferris State College and Central Michigan University have recently combined their externalized educational resources in a joint program which provides for a sequence of environmental health degree opportunities from the associate degree through the masters degree levels. This program has been initiated within the State of Michigan on a two year developmental basis, and will be expanded as experience and need dictates.

The pace of technological change and continuing demands

for adjustment and expansion of environmental health services have underscored the need for the development of new or expanded competencies on the part of the practitioner. Continuing educational programming and the awarding of CEU's are becoming an increasing non-traditional function of the undergraduate program. Most accredited programs find themselves under pressure from their regional practitioners to provide specialized courses in new or emerging technologies and practices in an externalized continuing education format. This has value as a stimulus to the resident faculty to keep abreast of the operational needs of the practice, and can provide motivation for curriculum changes. On the other hand, it also creates competition for the time of fully committed teaching faculty.

While there is growing interest and demand for continuing educational programming, there remains a nagging state of confusion and fragmentation of effort. On one hand, there is the challenge that while the concept of continuing education as an effective means of maintaining or extending professional competency has sound theoretical basis, in practice it has failed to prove itself under rigorous examination. While individuals may learn new knowledge and acquire new skills, there is an apparent breakdown in their transferral to the field of practice. There exists a need to develop methodology which will overcome this weakness.

There also is a need for professional development of a more cohesive and unified national approach to the organization, delivery and accountability of programs designed to provide continuing education opportunities. There currently are at least three separate projects under way at the national level to study and develop continuing educational systems for the environmental health profession. The University of Washington is in the process of completing a governmental contract to develop and test a regional continuing competency education system, including needs assessment, course development and evaluation. The regional model is being designed with national strategies in mind. Concurrently, the National Environmental Health Association is under contract to determine the profile of national need for environmental health continuing education and to develop and test self-paced learning materials to ameliorate identified competency needs. Finally, the National Council for Continuing Environmental Health Education has been separately incorporated and has developed criteria for the review and awarding of Continuing Education Units for environmental health educational programs and has established

a national record keeping system.

As individual states begin to recognize the need for assurance of controlling environmental health competency in their sanitarian registration programs, it is anticipated that the professional coordination and the programming at the national level may provide the essential educational guidelines and support to maximize the effectiveness of the overall educational efforts at national, state, and local levels. The challenge still remains to assure a unified and nationally consistent approach to continuing education for the environmental health profession, such as now exists for the undergraduate degree programs. Failure to do so in a timely manner may result in contradictory initiatives which may complicate and delay the formation of a strong, unified national continuing education program in environmental health. Ultimately, the outcome of these varying levels of investigation, design and programming for continuing education at the national levels can be expected to involve the faculties and resources of environmental health undergraduate programs, if not the scope and content of the programs already in place. They will be watched with interest over the coming months.

Forces for Change

As one looks back over the history of environmental health education at the undergraduate degree level, it is surprising to note that programs specifically designed to produce environmental health personnel were virtually non-existent prior to World War II. In fact, it wasn't until the late fifties and sixties that educational institutions, encouraged by professional leadership and the availability of allied health manpower funding for sanitarian education, began the development of the array of undergraduate programs, including those which have been accredited since 1969. There is ample justification to believe that there will continue to be expansion and sophistication of environmental health education processes during the years ahead.

Environmental health curricula reflect the perceived needs of society and the profession for competent environmental health manpower. The environment is a highly dynamic system which daily confronts society with new and challenging crises under the onslaught of human activity. Environmental health professionals and educators will be challenged to maintain an holistic and responsive outlook regarding the scope and character of environmental health practice. We must be constantly alert to

the new and emerging environmental health competencies required to maintain a healthy balance between human needs and desires and our ecosystem.

Undergraduate education programming will become increasingly sophisticated in areas of environmental epidemiology, toxicology and the management and control of toxic and hazardous wastes. The areas will require a strong shift away from the heavy emphasis upon biological studies, which dominated curricula of past years, to increasing concentration on chemical and physical sciences and their relationship to environmental stress. Our graduates also must be ready to function effectively within computerized parameters and to maximize the advantages of electronic surveillance systems. These scientific and technological areas of emphasis will need to be balanced with increasing emphasis upon knowledge and skill in the areas of environmental economics and law.

SUMMARY

Tomorrow's educational curricula are not inviolate and must be conditioned to meeting the challenge for change. Forces for change are a constant denominator in the factoring of education formula for preparing the environmental health practitioner. Only through the maintenance of close linkages between the academic community and the environmental health profession and its manpower systems can the viability of environmental health curricula for meeting societal needs and goals be assured.

Environmental Health Training

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INTRODUCTION

The National Institute of Environmental Health Sciences' mission is biomedically oriented. Our institute considers environmental health to be that part of public health concerned with identifying, predicting, understanding, assessing and ameliorating the effects of toxic factors and compounds in the physical environment on human health. Therefore, we are engaged in and support research which seeks to develop the knowledge necessary to identify those chemicals which are most likely to be toxic to man and to understand how they damage health or cause disease. This type of research focuses on (1) metabolic studies (how the body processes the chemicals); (2) mechanisms of action studies (how normal body processes are disturbed by the presence of the chemical and/or its metabolites); (3) test development efforts to find new methods to better predict the potential hazard to man of exposure to environmental chemicals; and (4) epidemiological methods identifying various potential health hazards now in the environment. The results of this research are of vital importance to regulatory agencies since a new testing methodology or new information about a regulated chemical often shows the need for a modified regulatory posture. But since there are over 4 million chemical compounds known today, and each year many thousands more are synthesized, and of these 500 to 1,000 new chemicals are commercially produced each year, the task of risk assessment which leads to regulatory decisions is enormous.

R&D Areas

- Environmental Toxicology
- Environmental Pathology
- Environmental Mutagenesis
- Environmental Epidemiology/Biostatistics

The environmental pathology area deals with the details and time sequences of molecular, structural, and functional changes that eventually result in illness or death. Efforts are being made to define early changes at threshold effect levels of toxicants to facilitate development of early indicators of damage before the disease process becomes irreversible.

The overall goal of the environmental mutagenesis area is to safeguard the genetic heritage, reproductive capacity, and well-being of the progeny of man against environmental toxicants. Specific objectives are to develop reliable test systems with unequivocal quantitative relevance to man for detection and quantification of mutations to elucidate molecular and cellular mechanisms in mutagenesis.

And finally, the objective of the environmental epidemiology and biostatistics area is to identify and understand the casual associations between hazardous chemical, physical and biological factors in man's environment and human illness and death, or in the case of biostatistics, to support the efforts of researchers in the aforementioned fields in utilizing animal or other experimental data.

One can consider environmental pathology to be a subset of toxicology, but let me tell you how I differentiate the fields in an effort to clarify training program organization. Classically, pathologists are interested in studying the disease process from observation of altered tissue structure and function. Usually these observations come first and the search is for cause. On the other hand, the toxicologist attempts to understand and predict effects of known exposures to agents. Therefore toxicology works in the opposite direction, knowing cause and seeking effects. However, the two fields tend to become very similar at the bench, because the tools are the same. These are represented by the horizontal delineations such as biochemistry, histopathology and so on.

Likewise, environmental mutagenesis can be considered genetic toxicology, but due to the strong genetics component I find this is an easy program to separate, and I think our friends from the Environmental Mutagen Society would agree to this separation.

Extramural Training Programs

The NIEHS Extramural Training Programs support pre- and post-doctoral research training in all of these program areas which I previously mentioned. Currently about 65% of our training support dollars are, however, spent in the areas which we call environmental toxicology (90% if you include mutagenesis and pathology). This training focuses on the effects of environmental agents on tissues and it is a description of this type of training which will occupy the rest of my paper.

To better define what we mean by environmental toxicology, let us divide working toxicologists into the following classes; (1) clinical toxicologists who deal with acute intoxication by "poisons". These individuals determine causes of intoxication (which chemical?) and prescribe methods of treatment; (2) experimental toxicologists who are involved in the demonstration of safety or hazard of exposure to chemical or physical agents, such as environmental chemicals or drugs. These individuals do testing on experimental models. They design protocols and analyze results. Their work usually culminates with a report including protocol descriptions and the data obtained to support a conclusion on hazard level resulting from this safety evaluation; (3) predictive toxicologists who speculate on the hazard to man from exposure to chemical or physical agents. They attempt to gain knowledge about the pharmacodynamics and pharmacokinetics, mechanisms of action, dose/response relationships, comparative metabolism, etc., of the particular chemicals involved. These individuals do research on experimental models in an attempt to extrapolate this knowledge to better assess the hazards to man of exposure to the chemical; and (4) forensic toxicologists who determine cause/effect relationships between poisons and pathologies.

The NIEHS supports the training of individuals in the second and third classes of toxicologists, focusing on those individuals who wish to study the effects of environmental agents.

Training Approaches

Now how are individuals trained for research careers in environmental toxicology? The answer is far from simple, but there are two schools of thought, which I do not consider to be mutually exclusive. One school says that an individual must first be trained as a scientist in a classical discipline, and then be trained to specialize in toxicology. This has been the general pathway by which today's established toxicologists have

moved into the field. Individuals in this school argue that a toxicologist needs to be a good basic scientist first so that the scientific method can be applied in well-defined experiments to determine the nature of the toxicity at the biochemical, physiological, cellular, or genetic level. The second school of thought is that toxicology is a discipline unto itself, drawing from various facets of the basic sciences. Therefore, a toxicologist is trained, not only by taking courses in the classical disciplines but at the same time by taking courses in toxicology and in special topics which emphasize the interaction of environmental chemicals with the biochemical system, the organelle, the macro-molecule, or the tissue component.

The second philosophy of training identifies toxicology as a more unified scientific discipline. Our training advisory group wrote that "this trend undoubtedly reflects the increasing need for individuals who have a broad general knowledge and understanding of the major principles and concepts of toxicology and who, as a result, are better equipped than most of the specialists to design and conduct research protocols for toxicological assessment of chemicals and to evaluate the results of these studies". They called these individuals generalist toxicologists and were referring to people trained for example, in Ph.D. curricula which provide, in addition to courses in the basic biomedical disciplines mentioned before, courses which relate and apply these disciplines directly to the study of toxic effects.

The training of toxicologists may differ beginning at the postdoctoral level depending on career pathway. It is becoming quite apparent that there are needs for toxicologists to engage in two types of activities. The immediate need is for toxicologists to perform safety evaluations to provide data required by the regulatory agencies upon which societal decisions can be made as to whether or not the general population should be exposed to a certain material. These are the experimental toxicologists I referred to earlier. Likewise, there is a demand for individuals who will add to the fundamental knowledge base of the science of toxicology by furthering our understanding of mechanisms of actions, by developing new testing methodologies and thereby producing new knowledge about the effects of chemicals on organisms. This new knowledge will then allow safety evaluation procedures to become more precise and more capable of predicting the true hazard in the real world. Right now the state-of-the-art of toxicology is exemplified by the recent and on-going saccharine controversy, and the frustration associated with attempting to

make rational regulatory decisions on the basis of the unknown carcinogenic mechanism and the experimentally required doses administered to laboratory animals is a process which is uncomfortable for all parties involved.

Employment Opportunities

Now, let's look at where these individuals are employed upon completion of their training. First of all, there is an ever-growing demand on the commercial testing laboratories to provide as a service state-of-the-art safety evaluation of new chemicals. Informed individuals have told me that the demand for such services in the next few years is going to far exceed the capability of these laboratories to absorb the work, and the limiting factor is not laboratory space, or the availability of laboratory animals — it is the demand for trained individuals to design, conduct and interpret the testing protocols. In recognition of this situation, the chemical industry has been expanding its own capacity to do in-house safety evaluation. The same manpower shortage problems occur here, and currently an incredible amount of head hunting is going on within industry for individuals with experience in the safety evaluation of chemicals. This is resulting in many employment shifts from firm to firm of these few qualified professionals.

Secondly, regulatory agencies, particularly the EPA, need individuals trained as research toxicologists to recommend actions or further information on chemical safety assessment submissions. My information from the Office of Toxic Substances indicates that "checklisting" will not be the modus operandi, and sound scientific judgment will be utilized in implementing the Toxic Substances Control Act.

Finally, research in toxicology goes on in academia, in government and in private research laboratories, and in certain industrial laboratories. As I have stated, in the long run it is the activities of this group of people that will bring us out of the quagmire of questions regarding how to do proper chemical safety evaluation, and it is this type of scientist which the current NIEHS training program in toxicology is geared toward producing.

Manpower Research in the Occupational and Safety Health Professions—A NIOSH Priority

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"The Congress declares it to be its purpose and policy. . .to provide for the general welfare to assure, so far as possible, every working man and woman in the nation health working conditions and to preserve our human resources."¹

To accomplish this end there are a number of provisions in the Occupational Safety and Health Act for achieving safe and healthful working conditions, among which are the need to explore ways to discover latent diseases, establish causal connections between disease and working environment conditions, provide medical criteria which will assure, insofar as practicable, that no employee will suffer diminished health, functional capacity or life expectancy as the result of his work experience; provide for research in the field of occupational safety and health; and achieve these ends "by providing for training programs to increase the number and competence of the personnel engaged in the field of occupational safety and health." Considerations of health manpower begin with "supply," that is the number of professionals in a given category who are currently available, "demand," that is the number of job openings, and "need," that is the recommended number of professionals who should be in practice.² Determining the need to fulfill the requirements of the Act would be a complex undertaking which would have to take into account the varied activities of a highly industrialized society. Although there may be some legitimate objections to classifying manpower requirements in terms of certification and licensure,³ it is nevertheless convenient to

divide up the training requirements for the numerous specialists or experts required to monitor, assist and correct workplace hazards. The training and curriculum for each of the specialists is, within institutional limits, specific and complete, and designed to meet what is conceived as the ultimate function of the licensed individual.

To meet the manpower *needs*, that is to provide training, the basic requirements are facilities, teachers and equipment. Since it is not possible to cover the educational waterfront at any one institution or facility, cooperation between educational centers is essential.

Educational Resource Centers

To address meeting the needs by increasing the supply, NIOSH has funded twelve educational resource centers (ERC) as well as individual programs in the form of projects or grants. The success of the program, evaluated in terms of excellence, qualifications and number of faculty as well as increase in number of students attracted to and qualifying from the courses, has not been fully assessed yet. The number of students, although modest when measured against perceived needs, has increased over the short time the program has been in effect.

While it costs approximately \$20,000 per year for 3 years to produce a Board eligible physician, each of the other full time specialties costs approximately \$9,500.00 per year for a one or two year course. The short courses (days/week) cost the individual about \$200-\$300 each (these monies are returned to the ERC's or institutions which provide the training so short courses cannot be counted as educational costs to the institution although the number of attendees obviously do not always cover costs).

Comparisons have not been made between programs within individual ERC's or among ERC's because of inherent differences. One ERC may produce substantial numbers of industrial hygiene graduates, but only a few medical nursing or safety graduates. Another may be the reverse. Universities consider productivity in terms of graduates produced. The essential product of any educational system is the number of graduates and for some schools these are the premier index for assessing the status of any educational program. State funded schools use student head counts plus the number of graduates as basic variables for determining financial support and overall success.

National Needs

From NIOSH's point of view, however, the success of the program must be measured in terms of the national needs. How many occupational medicine physicians, nurses, industrial hygienists and safety engineers or professionals are needed to meet the requirements of the Act? Dolinsky estimated in 1974¹ that 1200 additional Board Certified Physicians were needed in occupational medicine with an additional 200 who had specialty training in other clinical specialties. Peterson and Skutchfield² point out it is too early to determine whether the ERC's have made a significant impact on these needs. The shortage or need for nurses is particularly noticeable. Currently there are 20,000 nurses in industry mostly licensed practitioner nurses (LPN). Few of them are registered; and very few, unfortunately, are formally trained.

"Demand" should not be confused with "need". Demand implies the number of job openings. The Graduate Medical Educational Advisory Committee (GMENAC) was chartered by the United States Congress to advise the Secretary of DHEW (HHS) on physician manpower requirements supply and implications for graduate education in each specialty. They estimate that the requirements for Board qualified full-time equivalent occupational physicians by 1990 will be 2,300 in the U.S.A. of which there are currently 656, a shortage of 1644. Requirements in the other disciplines of occupational health are not known. Currently only 24% of occupational health physicians are Board Certified. Approximately 72% of physicians who practice some form of occupational medicine consider themselves to be primarily involved in patient care. In practice, therefore, the titles Occupational Physician, Occupational Health Nurse, Industrial Hygienist and Safety Engineer do not always fit the job description and this has led to some confusion and not infrequently organizational problems.

OSH Generalist

From this confusion has arisen at least one new and less well recognized occupational title, the "Occupational Safety and Health Generalist (OSH generalist)". This specialist was created to meet the needs of small firms which do not have the means to employ industrial hygienists and safety professionals, yet require the skills of both professions. The group is not supported by any professional society or a certification

process. Nevertheless, NIOSH recognizes the function and need for these individuals and provides support for "generalist" programs.

It is well recognized that educational institutions offer a variety of viewpoints and philosophies and very different curricula for the same profession. The industrial hygienist graduating from Quinnciac College will have significantly different skills and viewpoints from one graduating from Hunter College. The course content and emphasis at these institutions differs significantly. This is true for any of the occupational safety and health specialties and there are continuing demands for some form of standardization in the training programs. In addition, the certified occupational health professional has been trained to perform what the Institution from which he/she graduated perceived as necessary to the task ahead. The theory does not always suffice; for example, scientifically qualified professionals are frequently asked to address management issues and since the Universities and Colleges do not normally teach management skills, the training has not been, in these cases, adequate to meet the requirements. This has led to frustration for the professionals and for their employers.

SUMMARY

Given that Occupational Safety and Health (OSH) manpower needs must be quantified, NIOSH (specifically the Division of Training and Manpower Development) is mounting a program designed to throw light on the problem. This manpower assessment project will be built in to the forthcoming National Occupational Health Survey (NOHS 2). The object of this project, like its predecessor (NOHS 1), is to identify hazardous substances in the workplace and 5000 firms will be surveyed. It is hoped that with minor modifications the survey can also obtain objective manpower data. This data would cover a wide range of SIC codes, sizes of plants, types of hazards and OSH manpower staffing. It is proposed that an objective model can be developed with the help of qualified professionals in the OSH field which may incorporate certain key variables ranking the health hazards against the manpower necessary to manage and control exposures and safety hazards. The model will represent a method to calculate needs for OSH manpower. Since the approach is new and untested a feasibility study will be necessary. It is believed that the study can be accomplished within a year. The key steps to achieve the final goal include;

1. Develop and seek approval of manpower questions (OMB approval is required).
2. Develop a pilot study of the feasibility with OSH professionals, and representatives of professional societies to determine if the methodology is appropriate.
3. Develop and award a contract for the pilot study.
4. Continue (or discontinue) study based on feasibility.
5. Complete study, assemble data, analyze and interpret results.
6. Report and disseminate results.

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Educating the Resources Manager of Tomorrow

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INTRODUCTION

Resource management is a highly complex enterprise which is rapidly demanding a level of skill, training, knowledge and understanding only partially extant in the profession today. This honorable and highly ethical career cannot much longer be characterized by the image we now have of the on the ground forester, wildlife biologist, fisheries specialist or agronomist. We know far too much today to be at ease with these images.

We have the spectre before us of *the limits to growth* and more recently, the *Global 2000 Report to the President*. These scenarios more than dimly hint at the consequences of our increasingly stressed environment. They call for policy changes, strategies which will improve social and economic conditions, restraints on development and improved resources management. But they are silent on who will alter policy, develop strategies, or manage the resources. They are not explicit about human resource development, on the education or training of those resources and on the means to move those resources into positions that will make a difference. Ultimately, it will take manpower to make the difference but the projectionists do not commit themselves on this issue.

The recent N.S.F. report on the status of science, engineering and mathematics education in the U.S. attempts to quantify our manpower needs in these critical areas but is not optimistic about fulfilling those needs. How on earth does our government hope to develop the brain power needed to address the scenarios if it refuses to acknowledge the needs?

Global 2000 Study

I believe that the Global 2000 study makes reference to our national brain power deficiencies when it states that;

To meet the challenges described in this study, the United States must improve its ability to identify emerging problems and assess alternative responses. In using and evaluating the government's present capability for long term global analysis, the study found serious inconsistencies in the methods and assumptions employed by the various agencies in making their projections.¹

The study goes on to say:

...our federal government requires a much stronger capability to project and analyze long-term trends (thereby) improving the present foundation for long-term planning. On this foundation rest decisions that involve the future welfare of the nation.²

Department of Interior Study

While this report is specifically critical of government capabilities, much the same could be said of the private sector. In a recent study undertaken by the Department of the Interior, the sample of private sector resources managers queried indicated that manager's activities are constrained by governmental requirements and fragmentation, legal considerations, political pressures, unproven management strategies, scientific uncertainty, lack of corporate support and economic considerations. All of these constraints exist in the public sector also.³

While these conclusions go beyond citing brain power deficiencies, they nevertheless give credence to the argument that we need a better way to do business with more skilled human resources.

It would be generous to say that neither institutions nor professionals could have anticipated the impacts of new responsibilities that require sophisticated information synthesis; attention to resource values; a team approach to problem identification and solution; considerably more sensitivity to the public; much more inter-institutional cooperation; broader, more holistic perspectives on the issues; and greatly modified organizational patterns that could accommodate the above requirements. I believe that many of us have long recognized that new ways of doing business were in order, but we have been slow to react to the need. We now need to seek the means for retooling our organizations, our people, and our procedures

to meet the challenges presented by our complex environmental problems and our equally complex regulatory remedies.

Change in Educational Patterns

I want to look at one aspect of this retooling in more detail and that aspect is change in the educational patterns of resource management.

First let me share with you what resource managers have to say about the state of their profession. In the Department of the Interior study, managers from many government agencies were asked to comment on their jobs. Here are a few of those comments which will give guidance to how we might retool.

"Individual resource managers are expected to possess an extremely wide range of skills and knowledge. In order to perform the broad spectrum of duties that resource management entails, resource managers must be managers, planners, problem solvers, politicians, and researchers. The enormous demands on the resource manager's skills and knowledge are compounded by the rapid rate of change that occurs in the field. New legislation and regulations are constantly being created, new scientific discoveries are made, and social and political crises occur—all of which affect the resource manager's job. The very fact that our knowledge of the ecosystem increases rapidly each year will, ironically, always be a constraint on the resource manager because he or she will always lack complete knowledge of the consequences of our interactions with natural systems.

"The more we unravel the ecosystem, the more we see the limits of our foundation of knowledge. Actions thought benign are found to have second- and third-level effects never contemplated.

"Several of the respondents went on to say that it does not matter that this knowledge problem really besets all scientists. What is critical is the time it takes to transfer new knowledge into practice."

Many of these resource managers came into their job with scientific or technical backgrounds. As they assume positions of greater responsibility, they need additional skills in personnel management and supervision, finance planning, and other general administrative areas. For instance, weaknesses in written and oral skills were the deficiencies most frequently cited by the federal employees contacted. These skills are becoming increasingly important as resource managers interact much more frequently with the public. Similarly, several

respondents said there is a great need to teach resource managers human resource management as an integral part of their overall curriculum, whether in an undergraduate, graduate, or in a continuing education program.

There is a growing demand for resource managers to learn more economics, modeling and other quantitative techniques and conflict resolution. Students need to learn how to work in an interdisciplinary framework. One respondent addressed this question with a comment about the fact that not enough students are trained to integrate information and to interact with other disciplines: "There's a need to think about working on an interdependent system. Right now, in interdisciplinary education the parts are episodic. They don't appear connected."

Another respondent explained that the system has not encouraged the development of integrative capacities because: "... persons who perform roles within conventional disciplines have not defined roles the way they really exist."

"The current system does not adequately consider the long-term implications. The time perspective needs to be expanded. Managers need a 'futures education' that gives them a sense of the earth's resources and the ethical and moral responsibility to the future."

Many contend that current, fashionable interdisciplinary training is lost on people who are not firmly grounded in at least one technical or scientific area of study. Faculty and administrators surveyed claimed that there are inherent weaknesses in interdisciplinary programs. For example, students do not develop a sufficient depth of understanding in any one area. As one respondent remarked: "The environmental science programs currently offered are 'chop suey.' Students are not learning in depth, nor are they learning how to be circumspect. The programs do not provide the student with sufficient expertise in at least one discipline. In certain instances, students have too much latitude in the choice of courses and independent study."

In other words, academic preparation in these programs has become too general, while the trend in resource management has become increasingly more dependent upon teams of specialists. This reinforces the need for specialist training. Furthermore, the complexity of resource management issues demands that more technical expertise be developed in a wide range of areas.

To summarize the foregoing, managers are saying that they need more education and training in:

- planning, problem solving, politics, futuristics
- personnel management and supervision
- rapid information processing and integration techniques
- administrative skills
- communication skills
- human resource management skills
- team building
- modeling and quantitative techniques
- conflict resolution

Current Training—Doesn't Fit Need

In view of the above, the kind of training and education typically experienced by today's managers is simply not going to fit the needs. Let us then hypothesize about new curricular experiences which better reflect the needs as stated by managers and as set forth in, for example, the Global 2000 study. And let us also keep in mind that the generation scheduled to mature in the year 2000 is being born today—right now!

First of all, resources management will become a "tracked" profession. I envision three levels. Entry level will be the resource technician requiring an undergraduate degree with emphasis on developing skills in the utilization of instrumentation devices. Background knowledge will be disciplinary (rather than interdisciplinary) forming about one half of the total curricular time. The technician will graduate completely capable of routinely using E.D.P. techniques in his or her own work. The technician will have had direct field experience as part of an interdisciplinary team working on a fairly large scale project of regional significance. The object of the team's efforts is to create a mathematical model of the area under study. In short, the technician has highly adaptable technical skills coupled with a fairly narrow discipline based background and well developed teamwork experiences. (The "solitary" person should no longer be encouraged to enter the field of resource management.)

Level two, the graduate, pre-doctoral candidate will become the resource manager. The curriculum will first trace that of the technician but graduate work will become interdisciplinary with additional considerable emphasis on mathematical and statistical modeling. The candidate will supervise the undergraduate team problem solving project, thus gaining personnel management experience. The manager-in-training will also work as a team member during a practicum experience in

government or the private sector. Our manager will be as comfortable with economics as he or she is with ecology. He or she will rely heavily on the team technician for hard science but will be skilled in integrating information and projecting consequences. The manager's greatest asset is highly developed thinking skills.

Upon receipt of the graduate degree, the manager would be prepared to fill a middle management position after a six to eight month orientation. Additional training for this manager would occur on the job and lead ultimately to the position of resource administrator—the third level in the profession. Ascension from manager to administrator means a change from day-to-day involvement to a role in which policy formation and “mission control” become paramount activities of the profession. Our administrator might well have a second degree in public administration.

What Academia Co Do

What can academia do to make the necessary changes to meet the challenges posed by our global scenarios and by the concerns of today's resource managers?

First, be selective in your admissions procedures; attract the best and the brightest.

Next, examine the real world needs and get a handle on what the job really entails.

Reorganize substantive knowledge to make its delivery more efficient seeking commonalities across the disciplines and emphasize those elements.

Introduce available technologies that are the real tools of the profession such as data processing, and computer cartology techniques.

Don't permit any one to graduate without full knowledge of the role politics and economics will play on the job.

Help students fully examine and clarify the ethical nature of the profession.

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Skills and Competencies Needed for Natural Resources Management: An Employer Viewpoint

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INTRODUCTION

We first confronted the problem of educating skilled, competent environmentalists in 1968 when we collaborated in the development of the environmental science program at Wilkes College, PA. We were natural scientists—one a meteorologist, the other a geologist—and, therefore, our phenomena were of the real world and not the laboratory. Furthermore, our disciplines took their values and purpose from their relationship to societal problems, and when we practiced out professions we engaged in advancing human interests by overcoming obstacles presented by certain phenomena and taking advantage of the opportunities afforded by others. In no small sense of the word we were environmental scientists, though the spirit of the times required us to invert the statement of the problem: we now had to consider how human activity would affect the environment instead of vice versa.

It was the time when "Spaceship Earth" was fresh and exciting imagery and only the biology sub-discipline ecology had a conceptual framework suitable for organizing the new ideas that were relevant to the new problems so crucial to man's destiny—population, resources,* pollution of the environment. However, human ecology and the human ecosystem were far more complex than had been traditionally studied and the validity of extending the few ecological principles beyond the

* In this context resources were considered to be the materials used in agriculture, manufacturing, and power generation.

simpler systems was doubtful. Moreover, the dynamics of the human ecosystem encompass more than the laws of physical and biological systems; here socioeconomic factors and the entire spectrum of engineering activities feature as prominently. Clearly a journeyman level had to be established short of mastery of all these diverse skills.

Gradually over the five-year development period we emerged with a concept of environmental education not unlike that prevalent today. General courses are necessary for the purpose of producing an environmentally literate citizenry. They should make them aware of and concerned about environmental problems and what they imply. They should convey some understanding of the basic principles underlying elementary solutions and a desire to support sound management measures.

At a second level, the area where education and training overlap, planners, engineers, architects, lawyers, and other technicians and professionals are targeted. They are given increased knowledge and understanding of environmental problems and trained until competent in those areas of their practice which have environmental aspects.

Finally, the program includes the training of the environmental engineer or scientist for environmental assessment or management. He will have the skills necessary to solve complex environmental problems, to manage natural resources, and to develop strategies to protect and restore environmental quality; however, the specialized knowledge, advanced skills, techniques, and expertise acquired are usually concentrated in a single media or discipline.

TVA as a Natural Resources Manager

In his message to Congress on April 10, 1933, proposing the bill to create the Tennessee Valley Authority, President Roosevelt stated: "It should be charged with the broadest duty of planning for the proper use, conservation, and development of the natural resources of the Tennessee River drainage basin and its adjoining territory for the general social and economic welfare of the Nation." The TVA Act which resulted so charged it, though in more indirect language, and TVA has tried to fulfill this management role for more than 47 years. Its record as a natural resources manager is not one of unqualified success, but this is partly due to conflicts with other charges laid upon it by the Congress and partly due to the changing attitudes concerning what constitutes good stewardship.

A decade of building the dams was followed by a decade of

building the coal-fired steam plants, and this, in turn, was followed by the building of the nuclear power generators which is still in progress. The fertilizer program steadily expanded from laboratory development of new products proven in the greenhouse to pilot- and demonstration-plant proof of production technology and even to field testing by college experiment stations and on a limited number of farms across the Nation. The preeminence of these major initiatives coupled with the fact that TVA could only manage directly the natural resources of the rivers and the small amount of adjoining land it administered made natural resource management a secondary concern. Moreover, the management of the river for navigation and flood control was an immediate success that overshadowed for a while the loss in water quality in the lakes behind the dams and the accelerated erosion, heavy sedimentation, acid drainage from spoil banks, and noxious air pollution later associated with the coal-fired steam plants.

TVA's Division of Health and Safety was concerned about air pollution hazards from the time the first coal-fired plant was proposed at Johnsonville and throughout the 50's recommended higher stacks and tighter pollution controls, including precipitators for particulate matter and intermittent, operational controls for SO₂; i.e., generation cutbacks and switching to low-sulfur coal in times of poor dispersion. Operational controls were proposed only after TVA personnel had developed the first quantitative models for dispersion under various meteorological conditions. By 1975 this Air Quality Group merged with the Division of Water Resources to form the free-standing Division of Environmental Planning. In 1979 the merger of DEP with the Division of Forestry, Fisheries, and Wildlife Development to form the Office of Natural Resources produced the present programmatic management structure. At the same time the Environmental Quality Staff was created to provide policy guidance in environmental matters affecting all aspects of TVA operations.

The present structure throws into sharp perspective two fundamentally different aspects of natural resource management: programmatic management which provides the day-to-day stewardship, and policy initiatives which change the daily stewardship practices. Some insight into how these processes function and interact in TVA follows.

ONR Programmatic Management

ONR manages TVA programs that protect and conserve the region's natural resources—the land, forests, water, air, and

wildlife—while at the same time promoting the wise use and development of these assets. Its ultimate objective is to improve the social and economic well-being of the people of the Tennessee Valley. This is the corporate environmental policy in response to the charge placed upon it by the Congress. Its programs are carried out by four subordinate units.

Division of Water Resources—This division operates TVA's integrated water control system composed of 59 dams and reservoirs. Its activities affect about 4,500 miles of major streams in the region, including about 780 miles of commercially navigable channels of the Tennessee River and its tributaries. This management program—

- Protects against flood damage, not only along the Tennessee but also along the lower Ohio and Mississippi Rivers.
- Promotes commercial freight traffic along the river.
- Operates the reservoirs for the generation of hydroelectric power of an amount comparable to 50 million barrels of oil per year.
- Provides recreational boating opportunities as well as sport and recreational fishing.
- Insures that TVA facilities meet water quality standards.

In addition, the expertise of the staff is used to provide technical assistance to communities for improving water supplies, managing waste disposal, cleaning up pollution, spills, and restoring locally-owned hydroelectric facilities.

Division of Land and Forest Resources—This division has responsibility for the conservation and use of the Tennessee Valley's terrestrial resources. It manages some 350,000 acres of Federal land under TVA administration, including more than 11,000 miles of reservoir shoreline. Its management programs—

- Improve the quality and quantity of forest resources by offering a wide range of assistance to the 350,000 forest landowners.
- Improve the wildlife resources by pursuing wildlife goals in cooperation with appropriate State and Federal agencies, including management of key wetlands across the Valley.
- Assure a full range of recreation opportunities to the public and increase the economic contribution of recreation resources.
- Reduce the adverse impacts of strip mining.
- Nurture an appreciation of the region's historical, archaeological, and cultural assets.

- Provide environment/energy education to help raise the environmental awareness of the general public.
- Offer employment to some of the youth of the region, helping them develop useful skills while engaged in selected natural resource activities.

Air Resources Program—This staff coordinates TVA's efforts to improve and conserve the Valley's air quality, both for regional development purposes and for TVA's own activities. Its programs—

- Provide an air quality base away from strong pollution sources which can be used for regional trend analysis.
- Provide an air quality monitoring net in the vicinity of the coal-fired steam plants which indicates the compliance status of these plants.
- Provide meteorological data for a meteorological forecast center which stands ready to assist TVA operations, including fallout forecasts in the event of nuclear accident.
- Provide air quality and meteorological data which may be used to expedite permitting of prospective industries.

In addition, staff expertise is used to conduct research into air pollution dispersion, modeling in support of proposed power projects, and promoting community development that maintains the air quality standards.

Land Between The Lakes—This 170,000 acre peninsula between Lake Barkley and Kentucky Lake in western Kentucky and Tennessee was established in 1964 as a national demonstration in outdoor recreation, natural resources management, and environmental education. It is being developed by TVA as an outstanding example of multipurpose land use, showing how such diverse activities as hunting, timber harvesting, energy conservation, agriculture, and recreation can be carried on compatibly and with mutual benefit in the same area.

Resource Services—This group provides many vital services in support of natural resource management programs.

- Its Data Services Branch collects environmental data and publishes engineering surveys, flood investigations, hydrographic studies, etc.
- Its Computer Systems Development Branch supports many computer-related activities.
- Its Mapping Services Branch produces maps and other graphics, coordinates land acquisition and disposal, provides relocation services for displaced cemeteries and

utilities, and develops remote sensing techniques.

- Its Laboratory Branch provides routine and special analyses of air, water, biological, and other samples.

Environmental Quality Staff Policy Initiatives

EQS, formed in 1979, is a policy oriented, interdisciplinary group that is responsible for planning, developing, and coordinating TVA's corporate environmental affairs. It administers the major TVA environmental permit program; it oversees TVA's assessments of environmental impacts of new projects and TVA's compliance with NEPA commitments and procedures; and it coordinates the Agency's response to proposed environmental legislation, regulations, standards and guidelines. Perhaps most importantly it provides TVA's top management with policy advice on environmental matters and develops new environmental initiatives and courses of action for TVA. These policy initiatives change the management practices to reduce environmental impact or increase the benefit of existing practices.

- Recognizing that channelization of streams to reduce flood damage is not only costly but has the potential for adverse environmental impact, EQS has been instrumental in developing TVA policy which emphasizes non-structural alternatives such as high quality floodplain and watershed management.
- Recognizing that turbine venting technology developed within the Division of Water Resources would permit significant increases in the dissolved oxygen (DO) content of water released by TVA dams at low cost, EQS was instrumental in having the Board adopt the policy of improving dam releases in this manner.
- Recognizing that improved DO levels could be easily negated by industrial growth and poor management practices, EQS is presently developing policy requiring a higher degree of cooperation between TVA and Federal and State control agencies than before, with TVA performing technical services for the State watershed managers paying with EPA Clean Lakes Program funds.
- EQS has provided policy guidance to minimize conflicts and clarify land use and environmental improvement and protection policies regarding implementation of TVA 26a permits, Section 208 management practices, and preservation of prime agricultural land.
- EQS, having worked with other TVA offices to review TVA's present fly ash disposal practices and identify the

associated environmental problems, is now heading a task force which will review proposed remedial action and implement the most favorable.

- EQS, is presently working with a TVA task force and officials of the city of Knoxville toward the establishment of a demonstration project involving the use of municipal sewage sludge, and possibly fly ash in strip mine reclamation and revegetation.
- EQS is presently investigating with the Environmental Protection Agency the possibility of using the Tennessee Valley region as a National Laboratory for the testing of alternative regulatory approaches. This would lead to a series of demonstration projects designed and monitored jointly by TVA and EPA.

Skills and Competencies

We have been asked to address the question of what skills and competencies natural resource managers should have, considering the employer's viewpoint. We have attempted in the foregoing to provide the appropriate employer's context and have identified two somewhat different groups of practitioners: those who work on established resource management programs; and those who continually review the on-going programs and modify the policy guiding them as new technology, new management practices, or new opportunities develop. We attempted in the following to consider the present staffing of both groups to determine the common features and the differences in their skills and competencies. In this comparison we used occupation titles as a guide to skills and competencies of line personnel (professional and subprofessional level); educational backgrounds were used for this purpose when we considered middle managers and executives. Finally, since the policy group has just been staffed during the last year according to guiding principles set down by El-Ashry, we examine those principles, the means used to identify the associated skills and competencies, and compare this group to the other.

ONR Professional and Subprofessional Staff

Occupational titles have been carefully standardized by ONR personnel officers so that they might be linked to fields of training, skills and competencies, or interests and aptitudes, thus facilitating vocational counseling and filling vacancies. Therefore, these titles were held to provide a better estimate of skills and competencies than educational records, including achievement test scores.

For the purpose of describing the work force ONR thought was required to manage TVA's natural resources program, the number of people employed in each occupational title was recorded for subprofessional (TVA Schedule E) and professional (TVA Schedule D) personnel. Omitted from this list were clerical personnel and administrative personnel providing management service. Managers, too, were not listed here but were considered separately later. Construction workers are temporary employees of TVA and we are attempting here to analyze only the permanent work force.

The count of line personnel by title is given in the appendix for each element of ONR. This table includes 26 professional titles and 15 subprofessional; 457 professionals and 582 subprofessionals, a total of 1,037, comprise the line component of the program work force. Some grouping was clearly needed for further analysis.

A more useful table drawn from the data in the appendix is presented in Table 1. Here the titles have been grouped into six occupational divisions linked to fields of training and the departmentalization of ONR is ignored. This summary table shows clearly the dominance of engineering in the natural resource work force, the life sciences being the clear second.

Almost half of the line personnel, 60 percent of the subprofessionals and 35 percent of the professionals, are in the engineering division; about 23 percent, 20 percent of the subprofessionals, and 28 percent of the professionals, are in the life sciences. Together these two divisions account for about 72 percent of the total line component of ONR. The tabulated data in the appendix show that Civil Engineers, Environmental Engineers, and Biologists are the dominant subgroups. In a separate appendix entry these titles are described in greater detail relating to specific skills and competencies.

It should be noted that there are six levels of responsibility for all subprofessional titles and four levels for all professional titles. These are linked to training and experience. The education level for subprofessionals may vary from a high school education through a two-year certificate, to a non-related college degree; professionals have job-related college degrees at entry level and generally graduate degrees, occasionally the Ph.D., at the highest level.

ONR Managerial Staff

Occupational titles for managers seldom relate closely to field of training or skills and competencies. This is true in TVA even though here managerial ratings are assigned to research

Table 1. ONR Professional & Subprofessional Personnel by Occupational Division

Occupational Division	Sub-Professional	Professional	Total
Engineering	348	157	505
Life Sciences	113	128	241
Natural Sciences	31	44	75
Lab Sciences	23	5	28
Math/Comp.	14	47	61
Social Sciences	53	76	129
TOTAL	581	457	1,039

personnel and staff personnel advising in affairs of great importance to the Agency as well as supervisors. Therefore, educational backgrounds were the primary data examined as indicative of skills and competencies.

All managers had college degrees; most, however, had graduate degrees as well and this introduced ambiguities when precise classification was attempted. Therefore, for managers only the summary tabulation showing the count by educational field was prepared. Ambiguities were resolved by examining the experience record of the individuals. The six educational fields tabulated should then be directly comparable to the occupational divisions with the same names. The distribution of ONR managers according to educational field is shown in Table 2.

Engineering and Life Sciences are again seen to be the major fields, though Engineering (40 percent) is not as dominant over Life Sciences (35 percent), as it was with line personnel. Together, however, they comprise about 75 percent of the managerial staff. It is interesting to note that when the middle managers (levels 4 through 7) and the executives (levels 8 through 12) are considered separately; the dominance of Engineering over Life Sciences does not extend to the executives. In fact, a clear trend for reduced engineering influence over the progression from subprofessionals to executives is present in these tables, and it appears to be the only trend.

The educational level attained was considered in a cursory way by noting the number of Ph.D.'s in the middle manager and executive classes, there being negligibly few among line personnel. About 20 percent of the middle managers had achieved the doctorate and 33 percent of the executives.

Table 2. ONR Managerial Staff by Educational Field

Educational Field	Middle Managers	Executives	Total
Engineering	78	4	82
Life Sciences	65	6	71
Natural Sciences	14	2	16
Lab Sciences	3	0	3
Math/Comp.	4	0	4
Social Sciences	29	0	29
TOTAL	193	12	205
Ph.D.'s	38	4	42

Environmental Quality Staff

EQS has recruited 90 percent of its staff in the past year. Because of its function in formulating Agency policy in the management of natural resources one might expect that there might be differences in the skills and competencies of the personnel selected. The same measures were used; indeed, the EQS staff data were included in the earlier summaries of ONR staff. It should not affect the comparison to break out the EQS data, however, since they comprise less than 4 percent of the total.

Table 3 shows the distribution of EQS staff by occupational division and education field (there are no subprofessionals on EQS staff). Most noteworthy is the better than two to one domination of Engineering over Life Sciences with Natural Sciences second. However, this imbalance reflects the need for technical expertise in the administration of the permit program and the compliance program. The policy positions, then, are staffed rather equally with Life, Natural, and Social Scientists. The Ph.D. distribution parallels the distribution within ONR and the percentage is almost identical at about 20 percent. Considering statistical variability there seems to be little difference between the two groups.

It may be instructive to note the principles which formed the basis for El-Ashry's selection of staff. They were that each individual should be:

1. Technically sound.
2. Broadly experienced in areas related to natural resource management and familiar with environmental laws and regulations.
3. Interdisciplinary in outlook.

Table 3. EQS Professional and Management Staff by Educational Field

Educational Field	Professionals	Middle Managers	Executives	Total
Engineering	10	10	—	20
Life Sciences	—	8	1	9
Natural Sciences	3	7	1	11
Lab Sciences	—	—	—	—
Math/Comp.	1	—	—	1
Social Sciences	—	7	—	7
TOTAL	14	32	2	48
Ph.D.'s		9	1	10

4. Positively motivated as evidenced by entrepreneurial flair or identifiable accomplishments.

These were the characteristics he sought, as an employer, for natural resource managers. It is hard to identify these skills and competencies in occupation titles, educational fields, or even resumes, with the possible exception of the third principle. In this area the records revealed a clear tendency for cross-training in graduate school and supplementing this with short, intensive courses in other environmental areas. However, comparison with ONR managers over the full range is not possible and only time will tell if the choices were correct.

SUMMARY AND PROSPECT

For our purposes here we have seen that the roughly 1,250-person work force which manages TVA's natural resources programs is dominated by technically trained, engineering-type personnel, especially in the subprofessional levels. Civil engineers, their aides and technicians are in the majority, and their functions within ONR are mainly navigation control, hydraulic and hydrologic engineering, and mapping; environmental engineers are next with the number of water specialists exceeding the air specialists. Life scientists are a clear second to the engineers except among the executives. The major subdivisions to this class are: general biologists, aquatic biologists, terrestrial or game biologists, foresters, and botanists.

These statistics may not be typical of other natural resource management programs. TVA activities are heavily biased toward river management and this alone may explain the engineering dominance. We do believe the general features

would be similar with perhaps different emphasis in other programs. They indicate the availability of positions for those with high school diplomas or two-year college certificates, especially those from technical curricula. Professional level, however, requires a college degree in a related field, with graduate degrees being associated with advancement. About 20 percent of the managers hold the doctorate, but almost all have had some graduate training. It is our opinion that the best manager is a sound technician within his discipline or area of specialization whose perspectives have been enlarged by cross-training or short-course supplementation.

ONR does not expect that these statistics will change much in the future. It has built its management programs carefully and is confident that any management policy that requires good stewardship will substantially endorse the programs under way.

APPENDIX

ONR Personnel—Schedule D (Professional)

	OM*	R SVS	L&FR	W RES	LBL	EQS	Total
Biologist	4	—	15	72	7	—	98
Civ. Eng.	—	31	3	50	1	—	85
Env. Eng.	3	1	—	31	—	10	45
Land Use Specialist	—	—	32	—	—	—	32
Forester	—	—	21	—	3	—	24
Env. Sci.	19	—	—	1	—	3	23
Inst. Eng.	—	18	—	—	—	—	18
Prog./Analyst	—	17	—	1	—	—	18
Conservationist	—	—	9	—	8	—	17
Meteorologist	13	2	—	—	—	—	15
Recreation Planner	—	—	14	—	1	—	15
Systems Analyst	—	14	—	—	—	—	14
Mathematician	2	4	—	4	—	—	10
Botanist	—	—	2	4	—	—	6
Geologist	1	—	—	5	—	—	6
Mech. Eng.	—	1	—	5	—	—	6
Anal. Chemist	13	2	—	—	—	—	15
Landscape Arch.	—	—	2	—	2	—	4
Archaeologist	—	—	4	—	—	—	4
Research Anal.	1	2	—	—	—	1	4
Planner	—	—	2	—	—	—	2
Tech. Rpt. Writer	—	1	1	—	—	—	2
Computer Spec.	—	1	—	—	—	—	1
Safety Eng.	—	—	1	—	—	—	1
Resource Analyst	—	—	—	1	—	—	1
Agriculturist	—	—	—	—	1	—	1

TOTAL

457

**ONR Personnel — Schedule E
(Sub-Professional)**

	OM*	R SVS	L&FR	W RES	LBL	EQS	Total
Eng. Assoc.	28	104	3	41	1	—	177
Eng. Aide	10	110	3	29	5	—	157
Eng. Coop. Stud.	—	2	—	3	—	—	5
Biol. Assoc.	1	—	1	16	—	—	18
Biol. Aide	8	—	6	65	—	—	79
Conser. Aide	—	—	5	19	13	—	37
Scientific Aide	—	1	10	16	—	—	27
Sci. Coop Stud.	—	2	—	2	—	—	4
Chem. Lab Analyst	—	23	—	—	—	—	23
Lab Aide	—	1	—	—	—	—	1
Forestry Aide	—	12	—	—	3	—	15
Land Use Agent	—	15	—	—	—	—	15
Programming Tech.	—	12	—	2	—	—	14
Draftsman	—	5	2	1	1	—	9
Conser. Insp.	—	—	—	—	1	—	1
TOTAL							582

* Office of the Manager data includes Air Resources Branch.

Civil Engineer Series (General)

The general group of the Civil Engineer Series includes all positions which are to perform or supervise the performance of professional civil engineering relating to field investigations and studies, surveying, construction layout, engineering inspection of construction, interpretation of plans and specifications, and other civil engineering activities not specifically covered by specifications for other specialized groups of the Civil Engineer Series. Such work includes the civil engineering work involved in mapping and surveying; the location and construction of highways, railroads, and bridges; the layout and construction of a wide variety of structures such as dams, locks, powerhouses, steam plants, substations, chemical plants, river terminals, and miscellaneous buildings; the location and construction of transmission, power distribution and communication lines; and the work involved in carrying out other civil engineering activities required in the accomplishment of TVA's program.

Biologist Series

The Biologist Series includes classes of positions which involve the performance or supervision of broad professional and scientific work in investigative and research activities related to living organisms, their distribution, characteristics, life processes, and adaptations and relations to the environment. The work includes the application of scientific knowledge in the development of means of implementing or controlling such organisms and their environment. The Biologist Series has the following subgroups: Biologist (General); Biologist (Aquatic); and Biologist (Game).

Environmental Engineer Series

The Environmental Engineer Series includes classes of positions the duties of which are to perform or supervise the performance of work in the several fields of practice in environmental engineering. Such work includes the professional engineering work involved in the formulation, proposal, analysis, execution, and appraisal of plans and procedures relating to the engineering aspects of the TVA program as it concerns the health and welfare of TVA employees and the public. The general scope of the work involves participation in programs relating to malaria control, stream sanitation, and environmental sanitation.

Minority Education for Natural Resources Management

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INTRODUCTION

Nearly 17 percent of the civilian workforce in the United States is made up of members of racial or ethnic minority groups. But in natural resource professions, minority individuals are rare. Examples of employment figures of minority resource professionals range from some four percent to 2.4 percent in Federal agencies, and much lower for other government or private employers.

These percentages are tiny. But actual numbers are beginning to grow. No longer, for example, is the minority forester "the only." Now he or she is more likely to be "the only in the district." Last July there were 96 minority foresters working for the U.S. Forest Service. That seems like quite a few for a traditionally lily-white profession. Before we become too impressed with that number, let me return to percents — these 96 men and women made up 1.67 percent of the foresters in the Forest Service. The moral: educating and employing minority resource professionals is not impossible. But we have an enormous challenge to reach equitable representation.

What are the human resources from which we can draw? In American colleges, 6.6 percent of physical science majors and 9.5 percent of biological science majors graduating in 1976 were American minority students. Agriculture and natural resource majors, however, included only 4.1 percent minority students. These figures do not match the minority civilian work force at 17 percent. But they are larger than the current figures in resource professions.

Some of these students are enrolled in minority institutions

and some in predominantly white schools. This discussion will deal with each category separately, first considering environment-related offerings at minority colleges.

What are some of the responses from colleges and universities across the U.S.? What special efforts have been made and what new ideas have been proposed to increase the numbers of minority students entering these fields?

Natural Resource Studies in Minority Colleges

Minority institutions include over 100 historically black colleges, plus 40 newer predominantly black schools, mostly community colleges. Majority Hispanic student bodies are found in all Puerto Rican institutions and fifteen colleges on the mainland. Nine mainland institutions each enroll over 4,000 Hispanic students. Native American colleges number nearly 40, many of them sponsored by tribes. Institutions of each ethnic heritage will be discussed in turn.

Black Institutions

The traditionally black institutions, as a group, tend to have less academic prestige than some "white" colleges and major universities. Nevertheless, they play an important role in the education of black professionals. "White" colleges have a poorer record of retaining black students to graduation. Although only 18 percent of black students in higher education were enrolled in historically black colleges in 1975-76, 37 percent of the bachelor's degrees earned by blacks were from such colleges.¹ Black institutions are similarly responsible for a larger than proportionate share of graduate and professional education of blacks.

The historically black institutions are not the best choice for all black students, but they provide particular advantages for many. These colleges' record with bright students is reflected in the fact that they are still the leading baccalaureate source of black Ph.D.'s in the sciences. Black institutions also have an impressive record of remediating and educating students not served by other institutions, students with deficient academic preparation, and students from poor families. Black students may get greater leadership experience on black campuses, and talented students often have more personal attention from professors who take on a mentor relationship. Perhaps most important, students do not expend energy fighting the distractions of race or racism, but are free to concentrate on studies. Black institutions do not provide as much intellectual challenge as the most competitive of white schools; they are

not the Ivy League. They are appropriately compared with regional schools of similar size and resources, against which they measure up well.

For training environmental and natural resource professionals, the role of black colleges includes educating students in traditional sciences and in more specific professional fields. Virtually all these institutions offer biology and chemistry majors. A number of schools have developed some offerings in natural resources or environmental science.

Perhaps most ambitious is the new Center for Marine and Coastal Environmental Studies at Hampton Institute. Hampton's location provides a prime resource, on the James River estuary and Hampton Roads near the mouth of Chesapeake Bay, close to extensive wetlands and salt water marshes. Major components of the program will be Instruction, Basic and Applied Research, and Extension Services. Hampton hopes to develop cooperation with a consortium of regional colleges having significant minority enrollment, particularly to provide research facilities for faculty, but also with some shared options for students. A seminar to introduce pre-college students to the field will help attract participants. The marine science major requires biology and chemistry each year plus various math and physics courses and a summer internship which will include a tour at sea on a research vessel. Services to Hampton's non-academic neighbors will include workshops focusing on such problems as marine navigation, marine weather, and the seafood industry. The Center's program will be phased in over approximately five years.

The University of Arkansas at Pine Bluff is described by fishery educators at two majority institutions as "doing a whale of a good job" in fisheries. Pine Bluff has offered some courses and considerable extension activities for a number of years, and last September initiated a 4-year fisheries major. It has excellent faculty and facilities for this program; it hopes to be able to recruit more students.

The University of Maryland-Eastern Shore offers a B.S. in Environmental Sciences and an M.S. and Ph.D. in its new Marine, Estuarine and Environmental Science program. This MEES graduate program is university-wide, so students may take courses at any University of Maryland campus, but it is centered at Eastern Shore.

In early 1979, Dr. Ronald Field, then of Tuskegee Institute, developed a partial list of natural resource and environmental offerings at majority black institutions, including the following:

Bachelor of science degrees in natural resources are offered at Lincoln University in Missouri (since 1975) and Delaware State (since 1967). Delaware State offers options in wildlife management and fisheries management, and also a minor in environmental sciences with some courses in aquatics and pollution. Wildlife management degree programs are beginning at Southern University of Louisiana and Fort Valley State in Georgia. The University of the District of Columbia has graduated more minority students in wildlife management than the larger program at Delaware State where more of the wildlife students are white.

Fisheries biology or fisheries management courses not previously described are offered in Southern University (which also does research in aquaculture), Fort Valley State, University of Maryland Eastern Shore, and Delaware State. Jackson State in Mississippi carries on research and offers an M.S. in aquatic ecology, having initiated a series of marine biology courses in 1977. Savannah State has offerings in marine sciences. The University of the District of Columbia (formerly Washington Technical Institute) had the only four-year forestry program among historically black colleges, but that forestry program is no longer funded.

A well-established pre-forestry program has been functioning at Tuskegee Institute for the past dozen years. Tuskegee's program is supported by the U.S. Forestry Service, which provides personnel and other support, and by a council of advisors including representatives from major U.S. forest products corporations. The Weyerhaeuser Company and Foundation have provided substantial financial support, and additional funds have come from other companies. Annual summer jobs, mostly with the Forest Service or one of the corporations, provide students financial support and experience, though the quality of that experience ranges from mere manual labor to extensive exploration of the scope of the profession.

After two years or more of basic sciences, calculus, and introductory forestry courses at Tuskegee, students transfer to a university school of forestry for specialized courses. The University of Michigan has been the leader in this cooperative venture, but students have transferred to a number of other schools, recently including nearby Auburn University. Transfer to a large, "white", geographically distant school involves considerable culture shock for some students, and attrition has been high.

Black colleges also have a variety of offerings in environmental management and protection.,

Native American Institutions

Most predominantly Native American colleges are two-year institutions. Some have a history of support from church denominations or government, but quite a number are recently established by tribes or reservations, sometimes with cooperation of community colleges in the state. Most are struggling institutions beset with financial problems. Academic offerings tend to be severely limited, partly because the preparation of students in reservation high schools is often poor, and preparation in the sciences and math is frequently abysmal.

The strength of these institutions is that they can be responsive directly to the needs felt by their Native governing bodies. In much of the West, these needs include expertise to manage Indian lands — forests, water resources, fisheries, range land and energy resources, with related concerns for environmental protection. And several Indian colleges have instituted courses in such subjects. Examples in 1977 included forestry or forest technology at Nebraska Indian Community College of Winnebago, Nebraska; at Salish-Kootenai Community College, Kallispell, Montana; and, in cooperation with Michigan Tech, at Ojibway College, Baraga, Michigan. A natural resource program emphasizing rangelands is offered at the College of Ganado in Arizona. Little Bighorn Community College had a land reclamation workshop in cooperation with Argonne National Laboratories, and courses in related subjects. Navajo Community College at Tsaile had a similar Argonne land reclamation program. The Lummi Indian School of Aquaculture in northwest Washington State has a unique program of fisheries science for seafood cultivation, which includes training staff and running the tribal aquaculture operation.

Cooperation between these two-year programs and baccalaureate-granting schools of natural resources, paralleling the pre-forestry program at Tuskegee Institute or the WICHE exchange² might encourage some students to start their college training in close-to-home Native American institutions and then transfer for more advanced professional education.

Hispanic Institutions

Of colleges with significant Hispanic enrollment, a few have special programs in environment or natural resources.

New Mexico Highlands University offers both an associate and a B.S. degree in environmental science, emphasizing a

multi-disciplinary approach to understanding the environment, and application of basic science and engineering for solving pollution problems. About 60 percent of the students in the program, as in the university as a whole, are Chicano. Located in a traditional Mexican-American area, Highlands benefits from support of important *loya alumni* throughout the state.

The Center for Energy and Environment Research of the University of Puerto Rico receives support from the U.S. Department of Energy. Although its main function is research, the Center trains some graduate students. Dr. Juan Bonnet, its director, says, that half of the U.P.R. engineering graduates last year left Puerto Rico for the mainland, an example of the interrelationship of Puerto Rico with the rest of the United States.

At Texas A & I University, which has 51 percent Hispanic enrollment, 35 to 40 percent of the undergraduates majoring in range management and wildlife management are Mexican-Americans. They are heavily recruited upon graduation and get good jobs, says Dean Charles DeYoung.

The *National Environmental/Energy Workforce Assessment* lists East Los Angeles College, a 2-year institution with 66 percent Hispanic enrollment, as offering a concentration in environmental studies in its Department of Life Sciences.

Other universities having substantial Hispanic enrollment offer natural resource or environmental science courses. Statistics are elusive on the extent to which Hispanic students are taking these courses.

Developing Strong Basic Curricula

For minority colleges, however, providing specific natural resource programs, may be less important than concentration on quality courses in biology and chemistry. A strong major in one of these sciences can prepare a student for several career directions, and for graduate study in virtually all environmental or natural resource fields. The U.S. Environmental Protection Agency has been hiring chemistry majors, and would hire biology majors but for an over-supply of them on Federal Office of Personnel Management rosters.

Dr. Shirley Malcom, Director of the Office of Opportunity in Science of the American Association for the Advancement of Science, suggests that biology departments in black institutions tend to offer only traditional or bio-medically related courses. She urges the addition of ecology and behavior studies, which are inexpensive, and could perhaps even be taught by visiting staff from a zoo, a wildlife preserve, or the

college's psychology department "rat runners". Thus students could learn about whole organisms as well as their component parts. Precedents from other fields of concentration imply that research grants in resource or environmental subjects would stimulate interest in developing related course offerings.

Research grants awarded by the U.S. Environmental Protection Agency to minority colleges' have gone to departments of biology or sometimes chemistry. Under such grants Alabama A&M is investigating the use of municipal sewage sludge for agricultural purposes; Savannah State is studying South Carolina wetlands for nutrient flows and effects of pesticides on selected species of plants and invertebrates; Howard University is researching effects of ozone on plant development; and several other institutions are evaluating, analyzing, or determining techniques for other problems.

Cooperative education agreements, allowing students to get work experience, some income, and perhaps a sense of direction for careers, have been signed by a number of predominantly minority colleges and the EPA and other departments, whether or not specific environmental science courses are offered at these schools. In November 1980, the Northeast Fisheries Center of the National Marine Fisheries Service held a two-day workshop for representatives of one Hispanic and 26 black colleges on the use of cooperative education arrangements. Dr. Brad Brown of the Northeast Fisheries Center insists on some cooperative positions being designated for underclassmen, since there are so few minority fishery majors or graduate students. Thus minority science students are introduced to the field, and as a result several have decided to become fishery scientists.

Dr. Malcom of the AAAS suggests that the 3-2 dual degree pattern established for the study of engineering be set up also for environmental or resource degrees. After three years of study at a liberal arts college with solid science, math and English courses, a student transfers for two years to a college offering professional training, and earns a degree from each institution. Any number of minority colleges have arranged 3-2 programs with engineering schools; many should be equally able to arrange programs with schools of natural resources or environmental science.

The University of Michigan School of Natural Resources has had a cooperative program of this sort with liberal arts colleges for a number of years, but the arrangement with Tuskegee's pre-forestry program is the only agreement involving a minority school.

Cooperative arrangements of other sorts can be developed, including provision of professionally oriented courses in summer school or exchange terms at other universities, following which students return to graduate from their own college.

Minority Students in Resource Studies in Majority Universities

Three quarters of the minority students in higher education are enrolled in majority institutions, although too few of these students earn baccalaureate degrees. At the post-graduate level, nearly all education in environmental sciences and natural resources is offered at majority universities. Therefore, the responsiveness of these institutions to minority students will directly affect the numbers of minorities receiving advanced professional training.

Professional schools or departments of natural resources, both undergraduate and graduate, have established good records of preparing white students (including increasing proportions of white women), but they have not been notably successful in attracting and retaining numbers of minority students.

Successful efforts by particular schools or departments to attract and support minority students may stimulate actions at other schools. For ease of organization these efforts are categorized as recruitment, support, and so on. But, as in ecology, everything is related to everything else. Recruitment of minority students partly depends on those students' perception of the atmosphere and support for students once they are enrolled. Retention in turn depends on having recruited academically prepared students whose expectations are realistic. In fact, success in higher education is so dependent on adequate pre-college schooling, that earlier educational levels keep intruding into this discussion.

Recruitment

Most administrators of natural resource and environmental programs responding to Human Environment Center questions have stated that because minority enrollment is so small, the greatest need is recruitment.

In minority communities there may be limited information at home and at school concerning college and career choices. Special aggressive outreach by colleges and universities is needed, to inform minority students of career potentials and program offerings and to attract them to professional or graduate schools. Institutions should concentrate on direct

contact with young people in groups or schools having high minority participation. Here are a few examples.

The School of Natural Resources of Ohio State University is instituting a general grass roots recruiting effort in every county of Ohio, an important emphasis of which will be minority recruitment. In many counties minority high school biology teachers, community or church leaders and others will be sent packets of information and the name of a local alumnus of the School as a source for more information. School of Natural Resource administrators will phone and, as funding permits, visit these representatives to further inform them so that they may encourage local minority students to consider Ohio State's School of Natural Resources.

In the state of Tennessee, nearly 25,000 young people participate in 4-H wildlife projects and 9,000 in 4-H forestry projects, a fair number of whom, particularly in Memphis, Nashville and Chattanooga, are black. An exciting proposal to tap this group for potential entry to natural resource professional education was developed by Dr. Jim Byford of the USDA cooperative extension unit at the University of Tennessee, but the project is in limbo awaiting modest funding. The proposed project would identify black ninth and tenth graders in these 4-H programs, and provide special additional materials and support for local extension agents and volunteers to continue encouraging student interest.

Colorado State University College of Forestry and Natural Resources recently took the very sensible step of combining its recruitment with other science-related schools of CSU. Jim Volpa, who started as minority recruiter for the College of Natural Sciences in 1978-79, now also recruits for the College of Veterinary Medicine and Biomedical Sciences, which includes Environmental Health, and for Forestry and Natural Resources. Among other activities, he visits high school sophomore or junior science classes urging students to study hard in math and science because the competition is real, and then describes a wide range of science and engineering professions open to those who are prepared. Students seem to take the message seriously; counselors in the same schools warmly welcome Volpa's return visits to recruit seniors for Colorado State. A conference for northern Colorado and Denver area school counselors last year, outlining minority underrepresentation in science and engineering, provided another useful set of contacts.

Support for enrolled students.

Once minority students have enrolled, special attention must be given to retaining them. Many minority persons have become skeptical of the motivation of white institutions, feeling that efforts at recruitment are intended to boost minority student enrollment without expecting them to graduate; that is, institutions are more interested in appearances than commitment. Retention rates are considered acceptable when the ratio of minority students enrolled to those graduated equals the ratio for white students. Support includes financial, academic and counseling help and peer support.

Attitudes of whites. One element in support for enrolled minority students, perhaps the element hardest to pin down, is the attitude of white faculty and students toward minority students. The atmosphere in which a minority student must work can be distracting or discouraging. One black student told of entering a major university's school of forestry despite the comment from an already enrolled acquaintance, "Try it, you'll hate it." His experience bore out her warning.

Repeatedly, minority graduates, as well as those unsuccessful in white colleges, mention problems of atmosphere. This does not imply that all faculty and students are openly racist, although damaging overt episodes still occur. More common is unspoken prejudice, suspicion, lack of interest, or unconscious racism among white students and faculty members. As in the broader American society, stereotyping is common.

On the other hand, there are numbers of faculty and students of good will who want minority students to enroll and succeed. They need to know that good will is valuable, but not enough. They should familiarize themselves with minority communities, social structures, concerns and patterns if they are truly to understand when they listen to minority students. (The admonition to "listen" may point out the most important element in the development of communication.)

There are also, on a number of faculties, a very few people who do understand and fully support minority students. Some of these few are minority persons themselves. Some are whites who have had considerable experience with one or more minority ethnic group. Some just happen to be particularly supportive of students from non-traditional backgrounds.

Faculty attitudes matter for several reasons. In classes small enough for reciprocal contact, teacher expectation of success or failure has considerable effect on student performance.

If a teacher believes a student is not very bright, that student's failure to understand a point confirms the teacher's estimate. But if a teacher believes a student is bright, the student's failure to understand the same point leads the teacher to assume that the explanation was faulty, and to try a new approach. The amount of time and patience a teacher will spend on explanations, particularly with students whose academic preparation may have been deficient, may well be influenced by unconscious estimates based on ethnic stereotyping.

In most schools, each student is assigned a faculty advisor to counsel him/her on academic and career concerns. The understanding and empathy a teacher brings to this task will influence both the usefulness of the advice and the willingness of a student to accept it. In addition, observant faculty members and administrators can direct students to other resources on campus when needed. The selection of the advisor for each minority student should be based both on academic subject and on ability for true empathetic communication.

Research and Course Offerings.

Those who recruit, teach, or counsel in natural resource fields will be better able to elicit minority interest if they are well versed in the relevance of environment and resources to the well-being of minority people.

In fields that have long been obscure to minorities, and which do not typically provide great monetary reward, a demonstrated bearing upon personal, community and cultural needs may be the key to minority student interest. The ability of teachers to nourish that relevance, in learning and in practical applications, can be equally important to such students' perseverance in a non-traditional field.

The minority relevance of natural resource professions is commonly a function of the minority group and resources concerned. It is particularly important, for example, that Hispanic professionals take part in range management in the Southwest, that black foresters operate in the Southeast and that Indians develop professional capacity to help manage the Northwest salmon fishery.

Examples of Particular Programs within Majority Universities.

Programs for natural resource training for Native Americans, run by Native Americans, have been established at the University of Wisconsin-Stevens Point, and at Berkeley and Humboldt State University in California. Let me describe

the Humboldt State program as one example.

An open admission policy is in effect for this special program. It is left to the judgment of the program director as to whether a student is likely to survive the rigors of a resource major — a very useful option, given the problems of traditional tests for predicting success of non-traditional students. Much time and effort has been devoted to recruitment.

The program supports Indians in all majors in the School of Natural Resources — forestry, fisheries, wildlife, watershed or range management, etc. Several special courses are devoted to Native American concerns, such as Indian treaty law as related to resources, and interpretation respecting Native traditions.

Support services include an Indian counsellor assigned to the program. Arrangements can be made for tutoring, and for preparatory courses at the local community college. The support provided by the peer group of other Indian students may be the most helpful.

Quite a different example, now in its seventh year, is the joint project of Tennessee Technological University and the U.S. Fish & Wildlife Service. They have established a summer program especially for minority and women students (and Service employees) to add fishery or wildlife course work to their general biology major background. Two sessions are held each summer, open to college upperclassmen or graduates. Students come from many parts of the country, but the majority have been from traditionally black colleges in the South. In recent summers up to one third have been Fish & Wildlife or other governmental employees, adding specific course credits for certification as fish or wildlife biologists. Participants earn 11 quarter hours of credit per session.

Graduate departments of fish and wildlife should regard these students as excellent candidates for recruitment.

Allow me to comment on one final area — recruitment and support for graduate school.

Graduate education in science fields often depends on a particularly personal relationship with one professor. Admission may depend on recommendations and the willingness of a professor to accept a candidate. Support for a student in research and through his/her thesis depends on the interest of the mentor professor.

Thus it is incumbent on each school to encourage faculty members to expand and deepen their contacts with minority concerns.

In conclusion, increasing the number of minority students in

natural resource studies requires numerous responses to complex problems, but experience at a number of institutions indicates that the problems are not insoluble. With concentrated effort, perseverance and some financial support, effective programs are taking shape and minority students are being trained for resource professions. The challenge is to make these efforts flourish at their full potential.

References

1. National Advisory Committee on Black Higher Education and Black Colleges and Universities, *First Annual Report, 1977; Higher Education Equity: The Crisis of Appearance vs. Reality*, USDHEW/OE/BHCE, pp. 15 and 22. Other sources give other figures but the ratio of enrollment to graduation is similar.
2. Western Interstate Commission on Higher Education.

Education and Training to Meet Needs for Natural Resources Managers

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INTRODUCTION

How are natural resource managers prepared for their profession? Clearly, they come to their job with knowledge and a variety of skills gained through their general education, specific technical preparation, and related experiences. Often this preparation has been in traditional college programs supplemented by on-job experiences. Others have moved from entry level jobs over a period of time. As with most new professions, others have transferred their knowledge and skills from other areas.

As the criticality of this field has become more apparent to the Nation, it is fitting that the profession now examine its education and training with the goal of improving it. This paper examines aspects of education and training: 1) natural resources management as an occupational field, 2) educational agencies and institutions, 3) educational program improvement strategies and 4) professional input to education programs.

Natural Resources Management as an Occupational Field

Any discussion of education and training for an occupational field should include an examination of the occupational field itself. How many kinds of careers and occupations exist? All told, there are 21,741 separate occupations, also known by 13,809 additional titles making a total of 35,550 titles.¹

Which ones fall within the natural resources area? The *Dictionary of Occupational Titles* lists many occupations in the agricultural sciences which relate; for example, agronomist, forest ecologist, range manager, silviculturist, soil conservationist, and soil scientist.³ It lists such protective service occupations as regional wildlife agent, fish and game warden, and wildlife control agent. The *Dictionary* also lists such game farm occupations as game farm supervisor, game bird farmer, and game farm helper. It also lists such forest conservation occupations as smoke jump supervisor, fire warden, forestry aide, smoke jumper, fire ranger, forest worker, forest fire fighter, and tree planter.

Obviously, many of the titles listed in the *Dictionary* are not natural resources manager titles. Nevertheless, some of these occupations may make up the ladder and lattice of the natural resources field. The profession might ask itself which jobs constitute steps on its occupational ladders. Are some of these jobs prerequisite experiences for others? Are some of these jobs deadends? Might some of these jobs be appropriate work experience for students preparing to be managers? Could some of the seasonal jobs serve as part time employment for students working their way through college? Could college programs be designed or scheduled to take advantage of seasonal or part time employment opportunities.

A lattice may exist as well; that is, one career ladder may be closely aligned with another. Someone moving up one ladder might be able to step across to an adjoining ladder where opportunity for upward progression is better.

How clear are the career ladders and lattices in the natural resources field? The structure of jobs in natural resources may be largely influenced by the job knowledge and skills required, but also by the configuration developed by the employing agencies and by standards established by the profession itself. Employers tend to structure jobs for efficiency and to use available employees. Sometimes this does not contribute to quality or to worker satisfaction, for example the efforts to be more efficient in the automobile manufacturing industry has led to quality-control and employee problems. Sometimes the profession itself regulates career entry, progression, and transfer through self-protective licensure and certification. Licensure and certification may at first parade under the banner of quality control and public protection, but later develop primarily into a means of limiting the availability of employees and keeping salaries and wages higher. Consequently, someone wishing to move up or across the career ladder and lattice may

find that they must return to the ground if they wish to change ladders because they cannot use training and experience gained in a slightly different context. The health professions are an example of a field with this difficulty. Kintgen reviewed the literature on career ladders and lattices in the health professions and found that occupational analysis, curriculum analysis, articulation between educational levels, equivalency credit, and career opportunities for the disadvantaged were the principal areas of interest and concern.⁹

The Occupational Outlook Handbook describes such conservation occupations as foresters, forestry technicians, range managers, and soil conservationists.¹⁰ The *Handbook* advises that most of these occupations require a bachelor's degree with a higher degree desirable because of competitive pressure for the jobs available in the government or private sector. Among the trends are:

1. Increases in employment of forestry technicians have reduces the routine tasks of foresters and increased supervisory and managerial duties for foresters.
2. Keen competition for most jobs in the conservation occupations.
3. Increase in the demand for range managers.

Educational Agencies and Institutions

What institutions and agencies could play a part in the education and training of natural resources managers? Many, of course. Primarily it is a question of what role could be played by what agencies or institutions at what stage of educational and career development of individuals. Most of the education and training for natural resources management takes place in public institutions, rather than private ones.

Local Education Agencies

There are over 17,000 school districts in the United States. Each of these local education agencies provide educational services at the elementary and secondary level. It is at this stage of educational development that most students become aware of occupations and careers and begin to assess individual interests and capabilities. Largely as a result of the career education movement of the 1970s, many school districts are incorporating career awareness and exploration activities in regular programs, beginning in the very earliest grades. One of the first concepts developed with young students is the distinction

between goods and services occupations. This distinction is further differentiated into clusters of occupations which may be explored as groups. It is at this early stage that some students become interested in the natural sciences and in occupations related to conservation and ecology. At the middle school level some local education agencies have developed career exploration programs which help students find out more about specific clusters of occupations.

Most local education agencies have provisions for specific occupational preparation, either in regular high schools, vocational high schools, or area vocational schools. The vocational agriculture programs in these schools, open to both boys and girls, include production of agriculture, agricultural mechanics, sales and services, ornamental horticulture, and many other specializations. Most of these programs lead to entry level jobs and entrepreneurial opportunities or to advanced training at community colleges or senior colleges and universities. Any examination of education and training for natural resources managers must take into account the general and specific training available at these levels because this is where initial career choices are made.

Community, Junior and Technical College

According to Fontelle there were 1,044 public community, junior, and technical colleges in the United States enrolling 4,334, 344 full and part time students in 1979. In addition, there were 186 independent institutions at this level with an enrollment of 153,528 full and parttime students. While there has been a good deal of controversy over the relative efficacy of public vs proprietary postsecondary institutions in recent years, it is clear that most of the education and training at this level is taking place in public institutions. Enrollments at this level were up 4.3 percent in 1979; in fact, only once during a 20-year period has this growth pattern been interrupted.⁶

The terminal and transfer programs at two-year institutions represent significant opportunities for persons to enter the natural resources field and for the field to select technical employees. For some, these programs represent an opportunity to further explore a field, deciding later whether to transfer to a four-year college and to complete bachelor's degree requirements.

It is difficult to say with certainty just how many postsecondary educational programs exist in the natural resources area because program statistics are usually compiled and reported for specific reasons. Therefore, three tables were compiled

from as many sources to provide some idea of the extent of postsecondary education and training in related areas. One set of data is arranged in Table 1 to show the transfer and terminal programs in agricultural technology, forestry, and wildlife at two-year colleges.⁴

Table 1: Transfer or Terminal Programs at Two-Year Colleges⁴

Program	Number
Agricultural Technology	218
Forestry	238
Wildlife	176
TOTAL	632

Another set of data was compiled from a program directory published in the Technician Education Yearbook.¹¹ The number of programs in forestry, soils, and natural resources management and coservation is shown in Table 2.

Table 2: Technical Programs in Natural Resources¹¹

Programs	States	Number of Programs
Forestry	35	129
Soils	32	107
Natural Resources Management and Conservation	35	120

Associate degree programs are offered in community colleges, and some four-year colleges. A compilation of data about programs in agricultural technology and forestry/wildlife published by the College Entrance Examination Board⁷ is shown in Table 3.

Table 3: Associate Degree Programs⁷

Programs	Number of States	Number of Programs
Agricultural Technology	18	328
Forestry and Wildlife	41	143

Depending on the source of information it appears that there are between 218 and 328 postsecondary programs in agricultural technology, between 199 and 238 programs in forestry, and up to 176 programs in wildlife management.

The nature of these programs vary widely. Most include general education subjects, technical subjects, and related subjects. Most programs include some provisions for practical experience in the laboratory, field, or on the job. Many are developed with the assistance of advisory committees.

An example of a forestry technology program is the one at Hocking Technical College in southeastern Ohio.¹¹ The curriculum covers everything about the forest from the planning for establishing a forest to the time the wood is a milled product. A natural science base is emphasized in the first year, which includes such courses as botany, field biology, and entomology. Typical technical courses are forest measurement, timber harvesting, applied silviculture, forest management, and lumber grading and marketing. Hocking Technical College has an agreement with surrounding state parks, national forests, and some private land owners to use the forestry for field experience.

Four-year Colleges and Universities

The most direct route to natural resource management positions is through a bachelor's or graduate degree program. Such programs exist at colleges and universities in most states according to the College Entrance Examination Board as shown in Table 4.⁷

Table 4: Bachelors' and Graduate Degree Programs⁷

Program	Number of States	Number of Colleges
Agricultural and Forestry Technology	12	12
Fish, Game and Wildlife Management	45	80
Forestry	40	74
Soil Science	43	85

At the Ohio State University, the School of Natural Resources offers 59 courses in wildlife, forestry, and other natural resources subjects. These range from "Ecological Relationships of Forest Stands" to "Methods of Conservation Education" and can be combined with other courses available in the

University's 13 colleges. As with most land grant institutions, the teaching program is integrated with research and extension to capitalize on both theory and practice.

Educational Program Improvement Strategies

It is difficult to make changes in education and training when the educational enterprise is so vast and decentralized. There are strategies which can be used, however. One of these is through a systematic program of research, curriculum development, demonstration, personnel development, and dissemination aimed at specific changes. But this takes national resolve and a lot of money. Vocational educators' approach to this provide both an example and a vehicle for program improvement efforts in the natural resource management field, at least at the postsecondary (two-year college) level.

Vocational education program improvement was a priority item in the Education Amendments of 1976 (P.L. 94-482). In the three-year period 1978 through 1980 there were over 2,350 research, innovative and exemplary, and curriculum development projects conducted with \$60,000,000 of funding under this legislative provision.

These funds could be available for use in the natural resources area to improve and promote educational programs. The following are two examples of how program improvement funds have been applied to the natural resources field.

Salmon School District 291 of Salmon, Idaho has developed an agricultural program which provides secondary students with instruction in such areas as forest management, conservation, and fire control. Students receive classroom instruction in land survey, aerial photography, types of vegetation for different soils, fertilizers and herbicides, and mechanical skills needed in the forestry industry. Students receive classroom instruction and observe forestry operations.²

The Williamsport Area Community College, Williamsport, Pennsylvania upgraded and expanded their forestry curriculum by adding collection of fire weather data, maintenance of fire weather equipment, and determining the fire weather danger ratings from weather data skills to the community college courses; by adding collection of fire weather data and determining the fire weather danger rating from weather data to the secondary school forestry program; and adding fire weather data collection to the elementary school environment program carried on by the college.²

A review of the 2,350 program improvement projects show

that there are fewer than ten projects that relate specifically to forestry, wildlife, or soils. This would seem to indicate that we as educators have not taken full advantage of the opportunity to improve educational programs in natural resources. Natural resources is not the only area which has overlooked this funding source. Arrington found that agricultural education only accounted for 5.3 percent of the program improvement projects and 4.9 percent of the funds during 1978 and 1979.¹ Only 28 states funded any agricultural education projects and these ranged from one project in each of twelve states to twelve projects in one state. Funding in the states varied from \$1,376 to \$649,217. This wide variation would seem to imply that funds are available for agriculture and agriculturally related programs if educators make a conscious effort to secure them.

Each state has a research coordinating unit within the State Department of Education that is responsible for administering the program improvement funds received through P.L. 94-482. Representatives of the natural resources profession need to contact the research coordinating unit director to find out what the program improvement priorities area, to find out what the procedure are for requesting funds, or at the very least communicate to the director the program improvement needs in the natural resources areas so they can be incorporated into the overall priorities. In summary, professionals in the natural resources areas and educators who provide training for those who work in these areas should (1) investigate the availability of program improvement funds in their states; (2) seriously consider their role in addressing the federal priorities of equity/civil rights, transition from education to work, and basic skills; and (3) become more proficient at grantsmanship. These steps help take advantage of existing resources and upgrade or expand educational programs for natural resources.

Professional Input to Educational Programs

In the interest of providing the best possible training for those who work in the natural resources area, how could the profession work directly with the education to improve programs? The following are suggested activities to be applied at the elementary, secondary, and postsecondary education levels which would contribute to a larger, better trained manpower pool.

1. *Provide materials and field trip opportunities for elementary school classes.* Job impressions received by

elementary children will likely remain with them through their formative years. Therefore, it is in the best interest of potential employers to inform children about their business or profession through well conceived materials and enjoyable and informative field trip experiences.

2. *Furnish resource persons to serve on technical advisory committees, to serve on teacher curriculum committees, to provide inservice teacher education programs, and to speak to classes.* Advice is needed from the profession to ensure that education programs are current technically correct, and needed. Teachers must be kept up-to-date on new developments through inservice education. Resource persons often have more credibility on very technical matters than the instructors.

3. *Accept placement of cooperative education students.* A very important aspect of any occupational training is experience in the actual work setting which is often provided through cooperative education. The agencies and individuals involved in natural resources management need to help educators plan and supervise these job experiences.

4. *Provide facilities and equipment for class field work.* Although most education programs attempt to duplicate the job site as closely as possible, it is sometimes impossible for them to purchase the large and expensive equipment or provide the job site. The profession can help by contributing equipment or making it available at a reduced cost and by making their facilities available during "down" times to educational programs.

5. *Employ students on a part time and seasonal basis.* Students could profit from on-the-job training and the gradual transition from school to work provided by part time and seasonal employment. This would help to nurture the bond of mutual respect between employer and future employee.

6. *Provide personnel to teach on a part time basis.* Advanced or highly technical education programs often require a level of expertise beyond that possessed by the regular instructor. Providing part time instructional personnel not only ensures a quality educational program, but strengthens the understanding between the profession and the education program.

7. *Cooperate in task analysis and followup surveys.* In order to provide the most relevant and highest quality education program it is necessary to periodically conduct a task analysis of the job and to follow up program graduates to determine how well they are performing in their jobs. Without the full cooperation of the employers, this is impossible. Educational programs cannot improve without candid and direct feedback.

8. *Work with institutions to develop programs for retraining and upgrading professional employees.* Agencies involved in natural resources management must be attuned to employee self-renewal, upgrading or retraining. They must work with educational agencies to develop long-range inservice and advanced degree programs for staff. Most community colleges welcome such input as a means of adequately serving their patrons.

CONCLUSIONS

The natural resources field has matured to the extent that it should systematically examine its occupational structure and clarify issues and problems related to job entry and progression. It should examine educational programs at every level to determine if they are relevant and adequate. Deliberate efforts should be made to improve educational programs through a systematic research, curriculum development, demonstration, personnel development, and dissemination program. Natural resource managers should get involved in educational programs as advisors, teachers, resource persons, and cooperators in work experience programs. Changes can be made, though not easily. Efforts to make changes will be rewarded with better-prepared managers who are continually involved with the educational enterprise.

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Soil, Water and Related Resource Management Workforce Demand and Supply

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INTRODUCTION

The workforce currently available to provide for soil, water and related natural resource management, by most estimates, falls short of the needs. This is based upon identification of the problems by local, state and national resource conservation agencies. Surveys and inventories consistently show that soil erosion on croplands continues at a rate which causes soil loss in excess of that which can be sustained. According to the U.S. Soil Conservation Service, over 239 million acres or 58% of our cropland is in need of conservation treatment, to control the approximate 2 billion ton soil loss each year. Likewise, 406 million acres, or 75% of our pasture and rangelands are in need of conservation treatment.

In addition, soil erosion continues to result from non-agricultural land disturbances such as urban development, and industrial activities despite new controls in many states and a heightened concern nationally. This not only depletes the soil base at the site but generates serious pollution problems in downstream waterways. Such sediment pollution problems, which include sediment and related pollutants generated by agriculture, have become an important national concern and have resulted in state and areawide plans for control of these non-point sources throughout the nation. In most cases, the designated control agencies have been the 3,000 local soil and water conservation districts and their state agencies which have been conducting soil erosion and sediment control programs for up to four decades.

With regard to water and related resources it is difficult if not impossible to separate soil erosion and sedimentation problems from storm water management problems. Such problems, while controlled to the maximum extent possible under current and past program funding, continue to exist and far exceed the workforce available to provide needed control services. Storm water management is fast becoming a concern of our local soil conservation districts.

General water management problems such as upstream flooding, farmland drainage and irrigation water supply continue to exist and must be addressed both now and in the future. Agriculture is the largest water user accounting for 83% of the total water use. There is need for conservation of water for irrigation, a task which will require the assistance and expertise of trained technicians. Likewise, the loss of important agricultural lands continues at the alarming rate of about 3 million acres per year. Programs to reduce this loss are just becoming established in various parts of the nation. As momentum increases in this effort, it will probably be shown that there are not enough persons currently engaged in these programs to meet the needs.

Funding Levels Inadequate

However, we need not look far to determine why the workforce does not meet the needs. It is primarily because governmental programs, except in a few instances, are not funded at levels to support needed personnel. Let's take a look at some statistics. During the period from 1967 to 1981 the Soil Conservation Service of the U.S. Department of Agriculture, the primary *national* source of technical personnel to provide for the conservation and development of soil, water and related resources, went from 15,274 employees in 1967 to a current level of 13,500. A major portion of this nearly 1,800 person reduction was in the area of conservation technicians, the people who work with the landowners to install conservation practices. This reduction trend has been a continuing one and in light of recent trends to reduce governmental spending it would appear likely to continue. Funding proposals for FY 1982 would reduce this work force by another 400 persons.

During a similar period of time, and particularly during the past 10 years or so, the workforce available for these same conservation activities through state and local funds under the direction of states and local soil conservation districts, has increased to a total of nearly 6,000 persons as of January, 1980.

Special funding programs such as CETA have contributed to this increase with nearly 1,500 persons on CETA payrolls as of that date.

Surveys Show Need

Surveys conducted by the National Association of Conservation Districts in cooperation with State Conservation Agencies show that an additional 4,500 persons are needed for State and local soil conservation programs. These demand figures are largely based upon current programs and perceived needs and probably do not fully reflect new programs which are being recognized and developed such as non-point source pollution control, urban erosion control and farmland preservation.

From these figures and assumptions it would appear that the demand for soil, water and related resource management personnel is substantially in excess of the existing workforce. It is clear that there are not enough persons currently employed in these endeavors to meet the current needs—needs which appear to be growing as land use pressures intensify.

However, from personal observation, as state administrator of the soil conservation program in New Jersey, the most densely populated state in the nation, it appears that there are still many more people with training in these resource management areas than there are jobs available. While our urban soil erosion and sediment control program has provided employment for 35 to 40 additional persons since its inception in 1976, we have many more applications for employment than jobs available. Funding at the State level has simply not increased to meet needs and the funding generated by the local soil conservation districts has reached a stabilized level which may preclude significant additional employment.

Urban Erosion Control

—This state level urban-development-related erosion control program reflects a relatively new program thrust which may be important to project on a national scale. In a study released in 1977 by the National Association of Conservation Districts it was predicted that if each state enacted a regulatory program to control soil erosion and sedimentation to meet national goals for control of non-point sources of pollution from agriculture, silviculture, construction and surface mining, approximately 38,000 persons would be required on a full and part time basis. This would be a total of 20,600 employee years needed for the job nationwide and is a substantial workforce

need. The study was, of course, a projection and each state would be responsible for calculating its own needs. Whether or not this work force need will ever become a full reality will depend upon public funding, the enactment of State laws, and the extent to which State and local water quality management plans are carried out. There will obviously be a substantial public cost involved which may or may not be provided by the responsible levels of government. It would seem safe to say, however, that there will be significant work force needs in this area. While the number of new jobs will be dependent upon funding there will be a continuous need for properly trained people to fill vacancies resulting from constant turnover.

Personnel Needs

It may be important here to identify what kinds of personnel are needed in the soil, water and related resource management fields and what kinds of training are needed. In the figures I first presented about the existing work force of 13,500 in the U.S. Soil Conservation Service the ratios are about 60% professional level employees, 26% technician types with about 14% administrative and clerical personnel. The current State and local workforce of about 6,000 persons is comprised of about 7% administrative managers, 45% clerical, 21% technicians and about 26% equipment operators. The 4,500 projected additional persons needed in this State and locally employed force are for about 20% managers or administrators, 25% clerical, 44% technicians and 11% equipment operators.

For the 20,600 person years projected in the NACD study to meet national non-point source pollution control needs about 10% were projected as professional managers with an additional 20% in other professional positions with the remainder 70% needed as technicians. Clerical workforce needs were not evaluated in this particular study. While it is difficult to generalize from these figures it appears that the greatest need is in the area of trained technicians with the second most important need in the area of professional and management positions, if the clerical need is not considered.

While I have mentioned several various institutional work force needs it may be important to clarify how these institutions operate and how they relate to each other. My presentation is attempting to reflect the overall situation and needs for soil, water and related natural resource conservation. This work is accomplished at the grassroots level on the land itself primarily as a result of the efforts of the landowner or land user. This "land occupier" is ultimately the one who makes the

final determination to conserve, protect or develop his resources. I have not attempted to project what workforce needs might exist at that level. It is conceivable that significant potential may exist at this level for persons trained in natural resource conservation.

However, the primary force to motivate, assist and assure technical performance at the land occupier level is the workforce I have been talking about. The Soil Conservation District level is usually where this contact with the landowner is made. These districts are special purpose subdivisions of State or local government and are usually coterminous with one or more counties. At this institutional level the technicians expertise of federal, state and district professionals and technicians is assembled to help plan and implement soil and water conservation actions. The U.S. Department of Agriculture, primarily through the Soil Conservation Service, provides standards and some technicians for such work. Program policy and some administrative and more technical personnel are also provided at this implementation level by the local districts themselves and by State Conservation agencies such as the one which I represent in New Jersey. We have a four way partnership program which utilizes personnel at each of these levels. As I indicated earlier the trends appear to indicate a no growth picture for personnel from the federal government. However, significant growth has come about at state and district levels with more projected. These local government levels are where the problems are felt most strongly and are the levels at which there may be more latitude for program modification and expansion. In fact, national level proposals by the National Association of Conservation Districts and others would direct federal grants to the states and local districts, which, when matched by the local units, would generate programs adapted to local needs in accordance with broad national objectives. State governments through State Conservation agencies are also beginning to provide local grant funds to accelerate programs of local conservation assistance. Soil, water and related natural resource conservation is not an exclusive province reserved to any one level of government but exists at all these levels. It is likely that any new growth will be accomplished at the State and local district levels.

Training Needs

Since the basic purpose of this book is to determine education and training requirements I would like to share some of the observations and concerns we have in my State. Obviously

it is essential that the workforce be given adequate training in technical areas such as knowledge of soil, water and related natural resource management. Technical competence is essential. However, even if the person has the highest technical competence, effectiveness will be limited if he/she is not capable of communication with co-workers, supervisors or clients. Our experiences have shown that far too few of the persons who wish to become resource conservationists have sharpened their skills in communication, be it report or letter writing or in oral communication. Our needs are for people who, in addition to being technically competent, can communicate effectively. It is also extremely important that persons in the resource conservation field have a firm understanding of the workings and interrelationships of governmental institutions and agencies. In addition, it is important that they understand the employer-employee relations as it exists in government and in the establishment for which they wish to work.

One further comment on understandings and attitudes. The basic premise of the soil and water conservation program, as we have known it, has been to conserve and develop for maximum use and benefit of the general public with full recognition of the rights and responsibilities of private landowners. Persons who wish to enter the environmental workforce as it relates to soil, water and related renewable natural resources would be well advised to understand the differences between preservation and conservation. The landowners with whom they will work usually are not sympathetic to preservation only philosophies.

SUMMARY

In conclusion, there is substantial need for well trained persons to work in soil, water and related natural resource management. The accomplishment of well established goals in this area is vital to the well being of our nation. Our ability to produce food is directly dependent upon it. Much of our nation is currently experiencing a water supply crisis. Many astute leaders have said that water will be our next national crisis.

The actual realization of expanded programs to address these and other resource management issues will depend upon political and public support. Opinion polls conducted recently on a national level indicated that the public is willing to spend more money on the conservation of our soil and water resources. Realization of this will depend upon the action of

our political leaders at local, state and national levels. It appears clear, however, that a career in soil and water conservation will be a career with a built in future. Especially as states and local government strengthen their roles in this effort. If these local units to expand their roles there will be increasing needs for basic and supplemental training to develop and maintain needed workforce talents.

Supply and Demand— Forestry, Range, Recreation, Parks

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INTRODUCTION

The current employment situation is that there is a glut of persons with baccalaureate degrees seeking jobs in each of these four fields. Total employment has been increasing at a very low rate during the last decade. In forestry the major increases have been industrial employment as corporations have geared up to intensively manage their properties. Public agencies, particularly federal and many states, have remained on a rough plateau of employment, though there have been some specific exceptions. While the overall trend is slightly upward, the economy at present is pressing hard in the other direction. With expected decreases in federal funds for forestry and renewable resource programs and comparable tightening of state budgets attributable to reduced revenues within states and to lower contributions from the federal government, there is little hope for increases and a good possibility that employment will level off and possibly trend downward slightly. At present, an estimated fifty thousand professionals are employed in forestry and renewable resources. Only slightly over two thousand persons will be needed each year to replace those who retire or leave their particular professions.

If we examine the projections of the RPA Assessment, and if it is assumed that the United States will try to meet its commitments to manage renewable resources on all lands, there would be a substantial increase in demand for professionals in forestry, range, recreation, and parks management. In every case there is a projected increase in demand for the use of the resources by the American public. One may argue about the

short-term situation, but in the long term population pressures and world market demands will require that this country manage its renewable resources more effectively. For example, the United States is now a net importer of forest products. Our trade balances in forest products for a number of years have been of substantial significance on the deficit side, \$2.3 billion in 1979, greater in previous years. The United States has the land resource and production potential to meet all of its timber needs and to become a major net exporter in the world trade. Similarly we have a situation with our 650 million acres of range lands that will be called upon to produce meat to satisfy the demands of an increasing population. The latest estimate is that only 46 percent of our range lands are producing at about 41 percent of their potential. Obviously, there is a substantial need for range scientists to improve the quality and intensity of range management to insure high levels of meat production for the future. While recreation and parks cannot be costed out economically because they are not normally marketed, many areas are now overused and increasing population pressures will demand a greater allocation of resources for these needs.

Educational Trends

My discussion emphasizes forestry because I have a better definition of forestry educational trends and the records of degrees awarded. In the outdoor recreation and park management area, many people enter the fields with education from a variety of curricula and only in the past decade have the universities begun to focus on the professional needs in those areas. Similarly, many range scientists enter the profession with curricula other than range science or range management. There is difficulty in determining the number of undergraduate students who will ultimately seek employment in range activities, but the number appears to be well in excess of job projections.

After World War II there was a large enrollment of veterans in forestry schools with more than 8,000 undergraduate students being enrolled. This post-war peak occurred when more than 2,300 baccalaureate degrees were awarded in 1950. During the early 1950's enrollment dropped to about 5,000 and it was 1969 before another graduating class equalled 1950. After that the rise was rapid as this country became more concerned about environmental matters, and the management of our renewable resources became a common topic of conversation. University enrollments in forestry and related curricula

in the natural resources rose. By 1972 undergraduate enrollment in schools of forestry exceeded 18,000 and more than 3,000 bachelor's degrees were awarded that year (Table 1). Graduates continued to rise sharply with more than 4,000 in 1975. Since that time the number of degrees awarded has fluctuated a few hundred above the 4,000 mark. Undergraduate enrollments appear to have peaked in the late '70's and are on a slight downward trend, principally associated with the overall reductions in university enrollment. It is expected that enrollment trends will continue to follow the general population levels.

While graduate degrees fluctuate more from year to year than bachelor's degrees, master's were in the 500 range in the early '70's and have climbed to over 700 per year. The award of doctor's degrees has remained roughly level in the '70's at about 125 to 135 (Table 1).

Outlook for Employment Demand

Presently the number of graduates in forestry and the related renewable resources far exceed employment opportunities. As mentioned earlier, if we assume about 50,000 professionals employed in forestry, range, recreation, and parks management, we could expect an annual replacement level of about 2,000 per year. This is only about half the number of current graduates in forestry alone. While the employment picture may not be quite that dark, there are substantial numbers of persons who receive their baccalaureate degrees in the four areas discussed here who are not finding suitable employment in their chosen fields. One of the results of the great surplus of well-educated and trained professionals is that the salary scale is low. Surveys by the Society of American Foresters (SAF) show that foresters earn about \$6,000 per year less than engineers with comparable levels of education and competence. That differential is true for the graduating senior and the scales consistently stay apart throughout the average professional forester's career. This is a chronic problem with persons educated in range science, recreation, parks management, and wildlife. They all face the same difficult income problem attributable to some degree to the surplus of people in the field and importantly to the lack of understanding by the public of the jobs they perform.

But regardless of the projected demands for the use of our forest and rangelands, and the utilization of their outputs, there seems little likelihood of a substantial increase in

management intensity with its consequent employment surge in the 1980's.

**Table 1. SAF Forestry School Survey
Degree Status**

YEAR	Bachelors		Masters		Doctors	
	Enrolled	Degrees	Enrolled	Degrees	Enrolled	Degrees
1972	18,287	3,067	1,759	554	571	127
1975	22,345	4,002	2,208	538	592	151
1977	21,100	4,153	1,966	745	862	131
*1979	18,169	4,238	2,169	707	695	125

*Figures for 1979 are not complete. The Universities of New Hampshire and Washington had not reported when this compilation was made.

In some sectors we will expect modest increases in employment. In particular, industries will hire foresters and technical specialists in recreation, wildlife, and range science for the management of their lands. Consulting firms also will be increasing and will be providing modest additional employment opportunities. In contrast, the federal government and most other public agencies will be in a status quo situation with a mix among those who will be reducing employment because of reduced revenue and those increasing employment for special project activities. There may be some modest increase in employment of foresters and range scientists for the implementation of environmental regulations. If the Reagan Administration responded positively to the supply/demand situation as projected by the RPA Assessment, and planned to meet those requirements beyond the year 2000, there would be a substantial increase in program levels on both public and private lands and a consequent increase in employment. Similarly, if this nation responded to the recommendations coming forth from the Global 2000 report, there would be a need for more professional expertise in all renewable natural resource areas, particularly range science and forestry, to deal with world problems.

Another possibility to be kept in mind is that if the economic situation in this country continues to deteriorate and the

government chooses to establish an employment program similar to the Civilian Conservation Corps, it could conceivably generate a substantial job market expansion for professionals in the renewable natural resources field. Their immediate task would be to plan and supervise work, and to train personnel to carry out jobs in the renewable natural resources field. On many of our public lands there is a large backlog of work already identified in the planning process, therefore, mobilization of a CCC type employment program could move as fast as housing and support facilities would allow. The necessary professional staff to handle such programs probably could be recruited quickly because of the substantial number of graduates in forestry, range science, recreation, and parks management who are not currently employed to their full capabilities. Conceivably, several thousand jobs could become available in a few months, and the personnel would be available to fill them.

Employment Demand for Graduate Degrees

There is currently a good demand for Ph.Ds to fill positions in education and research, and excellent opportunities for holders of master's degrees in certain areas of specialization, e.g., mensuration, remote sensing, computer sciences, soils and nutrition, hydrology, and economics. Any substantial increase in research programs will severely strain the supply of Ph.Ds. At the present time graduate education programs need to be strengthened if we are to be able to respond with better, more effective, resource management technology to apply to our shrinking available land base. Research program needs have been well identified and prioritized in the renewable natural resources fields and lack only funding for their implementation, a perennial problem. However, growth of research programs will need to be at a modest rate lest the available research trained scientists are spread too thin or are siphoned away from educational responsibilities.

An Opportunity for Review of Personnel Management Policies

I suggest that now is the time for rigorous examination of the educational requirements at the undergraduate level in the several fields I have been discussing. There is also the need for substantial encouragement of graduating seniors to enter graduate study. It is also a time for employers to look closely

at their better personnel and make available to them opportunities for continuing education, and in particular, for the development of higher levels of expertise to keep up with rapidly advancing technology.

Public agencies, the federal government in particular, should use this time of over-supply of professionals to raise their qualification level for entrance grades in the renewable natural resources fields. This will ensure one of the principles of the civil service system, that the most capable persons be employed to serve the public. In the case of the federal government, there are two critical steps that should be taken, particularly in the forestry area: first, the qualification standards for entrance levels should be tightened and raised substantially (this has recently been done for range); second, the Office of Personnel Management should provide an open season for *all* employment registers each year in order that new graduates can be placed on the registers. Only by doing both of these things can we insure the employment of the most capable and best qualified persons to serve the public interests.

Overall the supply/demand outlook in the four areas I have discussed is bright from the standpoint of the employer; with a few exceptions the supply of professionals will be more than adequate. It is not a bright picture from the standpoint of the college student; the demand outlook is poor for the next several years.

Fish and Wildlife Management

**Louis S. Clapper
National Wildlife Federation
Washington, D.C.**

INTRODUCTION

The professions of fish and wildlife management and environmental law are relatively new, at least when compared to other sciences such as medicine, agriculture, and forestry.

Even though the art of fish culture and the propagation of fish in hatcheries goes back many years, fisheries management has come into being largely since the end of World War II. Wildlife management, at one time virtually limited to producing game birds or furbearers in game farms or ranches, is equally new. Aldo Leopold published his historic textbook, "Game Management," in 1933, but the employment of large numbers of trained people came just before the beginning of World War II with enactment of the landmark Pittman-Robertson Federal Act. This Act channels monies from federal excise taxes on the sales of sporting arms and ammunition into state wildlife programs. A companion Act, the Dingell-Johnson Act, was adopted later and funnels funds from federal excise taxes on sales of sport fisheries tackle into state fisheries programs. Both acts have stimulated the employment of biologists. Environmental law largely flowered after the enactment of key legislation, little more than a decade ago.

To a considerable extent, wildlife management and fisheries management are extensions of agriculture. Wild creatures, free roaming over large land areas or huge lakes and streams, are infinitely more difficult to handle than domestic livestock or poultry. Yet, there are some similarities. Basic tenets say that a given amount of land or water will support only a given number of animals and fish, unless stimulated and increased

by fertilizers, and that humans can play important management roles in ensuring that these numbers are of quality types. So, some of the early attempts at wildlife and fisheries management had origins within agriculture, as did forestry. Indeed, early state and federal governmental agencies dealing with fish and wildlife often were housed in agricultural departments.

The high value that people place on fish and wildlife has played an important role in development of the sciences of wildlife and fisheries management. Early colonists reaching America from Europe insisted that their charters stipulate that ownership of wild creatures be vested in all the people, rather than in a sovereign or landed gentry. Carried over into state constitutions, these principles make the states the primary custodians of these common properties. The Federal Government has the prime responsibility only for endangered species, marine mammals, and those species of wildlife which migrate between international boundaries. (Fish are state responsibilities, even though they move or migrate across state or international boundaries.)

Few Job Opportunities

The foregoing emphasizes a point. Since ownership of fish and wildlife is vested in the people and management is performed by governmental agencies, relatively little employment is found for biologists in the private sector. Unlike foresters, who can work with big lumber companies, for example, fish and wildlife managers have relatively few opportunities with private nonprofit organizations such as my own or in the academic field. Scattered jobs are found with consulting firms or with large corporations concerned with environmental impacts and/or land and wildlife management, but the bulk of employment is with local, state, and federal governmental agencies. Without serious competition from the private sector, most fish and wildlife compensation is tied directly to governmental pay scales. Private sector jobs often pay more. For example, the administrator of a state wildlife agency often handles numbers of people and budgets which would draw two to three times as much compensation from a private industry of comparable scope.

Nobody knows exactly how many wildlife and/or fisheries biologists/scientists are employed, but everyone agrees that the numbers of qualified people are greater than the job opportunities. Consequently, many qualified persons must find employment in other areas of effort, often totally unrelated.

Competent people believe that no more than 15,000 fisheries biologists/scientists are employed in North America. The number of wildlife biologists is somewhat less, probably in the neighborhood of 14,000. The numbers of environmental lawyers depends upon definitions, but certainly are not great.

An idea of the breakout between employment opportunities in the fisheries field is revealed in a survey of members of the American Fisheries Society, as of April 30, 1980. The membership at that time stood at 6,066, broken down this way: state or provincial employees, 1,560; Federal employees, 1,214; other governmental employees, 108; educational institutions, 694; students, 1,265; private organizations, 424; consulting firms, 371; self-employed, 137; nonprofit organizations, 128; and other, 2, with retired members at 163.

The Wildlife Society, pre-eminent professional group in the field, estimates that there are 6,500 individuals employed in wildlife work on the state level. Of these, about half are conservation officers (or law enforcement people), or supervisors, most of whom do not hold college degrees. The Federal Government employs 4,000 persons, with others in these categories: educational institutions, 1,100; private groups (industry, consultant firms, and organizations) 2,000; local municipal and county governments, 300; and miscellaneous, 100. Society members total 7,522, broken down this way: state employees, 1,751; Federal government, 2,031; educational institutions, 793; students, 1,742; private groups, 791; and others, 414.

Diverse Educational Backgrounds

Widespread public interest in fish and wildlife and natural resources has resulted in several rather unusual educational combinations. My own organization, the National Wildlife Federation, can serve as an illustration. Our chief administrative officer has a degree in soil conservation and agronomy, a background well-suited to his early wildlife habitat work, even though he subsequently has directed two state wildlife agencies as well as our organization. Another department head comes from the forestry field, and my basic background is journalism. However, among our attorneys, one also has a degree in biology; another combines law with political science; and a third with law and economics. Our professional staff includes people not only with degrees in wildlife science and biology, but also people with degrees in government, sociology, education, aquatic ecology, business administration, geography, journalism, engineering, organic

chemistry, meteorology, and accounting. All of these varied disciplines have roles to play in the conservation/environmental field. Our people use them in educational efforts such as producing magazine and classroom materials, in contact work with federal and state agencies on a variety of resource issues, and even in lobbying with Members of the Congress and state legislatures. The same is true, to varying degrees, of other major conservation/environmental organizations and agencies.

Fish and Wildlife Resources are dependent upon their habitats. A great many programs impact upon these habitats: energy development, such as strip mining for coal or tar sands, drainage and channelization of streams and harbors, intensive agricultural practices, water and air pollution, timber cutting, and livestock grazing, among others. Thus, fish and wildlife management often strays far afield from the creatures themselves.

Environmental Law

When talking about "environmental lawyers" one soon gets into definitions. What is "environmental law"? Who are its practitioners? Are they devoted entirely to the field or do they accept other legal assignments as well? Beyond generalities, nobody really knows exactly who they all are or how many of them they are. The best guess is that there are several thousand in the field, relatively few of which are with activist environmental groups. The Environmental Law Institute sponsors the Environmental Law Conference. In a decade, perhaps 8,000 lawyers have participated, to give an idea of the numbers.

Resource agencies and resource users have had attorneys for as long as they have been in business, but "environmental law" generally involves special legal efforts. Many attorneys began specializing with passage of landmark laws such as the National Environmental Policy Act (NEPA) in 1969. Or with adoption of the Clean Air Act amendments in 1970 and 1977, the Federal Insecticide, Fungicide, and Rodenticide Act amendments of 1972, the Surface Mining Control and Reclamation Act of 1977, the Federal Land Policy and Management Act of 1976, and the National Forest Management Act of 1976.

Many of these attorneys are "environmental lawyers" because they go to bat for protection of the environment under the banners of private groups. But are the legal people who help promulgate and enforce protective rules and regulations for federal and state agencies also not "environmental lawyers"?

Depending upon definitions, the Natural Resources Defense Council has 20 attorneys working on environmental problems to learn the numbers in private organizations. The Sierra Club has 15, the National Wildlife Federation 12, the Center for Law and Social Policy 10, the Environmental Defense Fund 8, and the Wilderness Society 3, with some other groups having one or two.

Probably the bulk of employment for environmental lawyers may be found with regulatory groups such as the Environmental Protection Agency or enforcement bodies such as state attorney general offices. In coping with these actions, many industries employ environmental lawyers. Some 125 law schools offer course work on environmental law.

The Future?

Federal employment "freezes" have inhibited hiring to a material extent. In fact, relatively few new programs are being organized. Most employment is coming in replacements for existing jobs.

"In view of the current and predicted world unrest, as well as the energy shortage, the prognosis for natural resource conservation concerns is not optimistic," says Richard K. Denney, Executive Director of The Wildlife Society. He hopes that newly-enacted Alaska lands and nongame legislation will provide some additional new openings. Carl Sullivan, Executive Director of the American Fisheries Society, forecasts that fisheries employment will be scarce in coming years. No material increases in opportunities for environmental lawyers appear in the immediate prospect.

Both the American Fisheries Society and the Wildlife Society have certification programs whereby wildlife biologists would be certified if they meet certain educational criteria and pledge to uphold a strict code of ethics and standards of professional conduct. The purpose: to stimulate public confidence in work of well-educated and experienced professionals.

Most certainly, this confidence is needed. As a rapidly-mounting human population continues to exert pressures on all types of natural resources, it will become increasingly important that they be managed in the most effective and efficient manner possible. We hope and trust that fish and wildlife management and environmental law will continue to be sufficiently attractive to bring bright and dedicated young people into these fields. Many of their rewards will come in satisfaction because they certainly are not among the top professions in financial remuneration or other benefits.

Making Occupational Information Available — State/Federal Interface

**Carol Kosofki and Neta Wall
South Carolina Operational Information
Coordinating Committee
Columbia, South Carolina**

The South Carolina Occupational Information System (SCOIS) is a new, computerized method of delivering up-to-date career, occupational, and educational information quickly and efficiently to the people who need it most. SCOIS was set up by the South Carolina Occupational Information Coordinating Committee, a consortium of state agencies including the South Carolina Employment Security Commission, The Office of the Governor, the Department of Education, the Department of Vocational Rehabilitation, the State Board for Technical and Comprehensive Education, and the Commission on Higher Education. SCOIS is one of the successful state systems in a national network aided by the National Occupational Information Coordinating Committee (NOICC). NOICC was set up under the Education Amendments of 1976 which called for a coordinated effort by the US Department of Health, Education and Welfare and the US Department of Labor to work with state committees to facilitate delivery of occupational information. Its mandate was strengthened under the Comprehensive Employment and Training Act (CETA) Amendments of 1978.

The South Carolina consortium is dedicated to providing students, adults, teachers, and counselors with the information necessary to explore and plan for careers and choose jobs in a logical and systematic way. SCOIS has computer terminals at various sites throughout the state. Additional sites use microfiche. These facilities provide access to vast quantities of occupational and educational information in the following categories:

- The Occupational File describes major occupations and their specialties regarding duties and working conditions; wages; advancement and employment opportunities; job outlook; physical and education requirements; education

and training opportunities; and sources of additional information.

- The College File contains detailed descriptions of two-and four-year colleges, universities and technical schools throughout the nation.
- The College Major File describes post-secondary education and training programs related to occupations in the system.
- The School Subjects File relates school subjects to occupations.
- The Apprenticeship File provides information on military training opportunities that relate to occupations.
- The Jobank File provides instant access to information on the current job openings in the State. This file is updated daily.

Computer terminal locations were located in sixty five high schools and career vocational centers, four libraries, ten community organizations, nine job service centers, six vocational rehabilitation centers and in twenty-four colleges, and technical institutes throughout the state. A total of 122 sites had such terminals in 1980, 42 of which were paid for by the user institution or organization.

The reproduction of a computer printout which follows demonstrates the search method of accessing the system, describes a selected occupation (ecologist) chosen to illustrate the process to identify a specific post-secondary institution which offers training needed to pursue the career.

THIS COMPUTER SERVICE IS A PRODUCT OF
THE SOUTH CAROLINA OCCUPATIONAL INFORMATION SYSTEM (SCOIS)
BROUGHT TO YOU THROUGH THE FACILITIES OF
THE SOUTH CAROLINA EMPLOYMENT SECURITY COMMISSION

ENTER YOUR ACCOUNT :
MESSAGE TO COUNSELORS AND ADMINISTRATORS:
THIS IS TO REMIND YOU TO MAKE ARRANGEMENTS FOR THE SOUTH CAROLINA
OCCUPATIONAL INFORMATION SYSTEM USER FEE DUE OCTOBER 1, 1981. IF YOU
HAVE QUESTIONS, PLEASE CALL CAROL KOSOSKI AT 758-3165.
SCOIS IS HAPPY TO ANNOUNCE THAT THE SYSTEM HAS BEEN UPDATED.
WHEN EXECUTING COIN PLEASE USE YOUR 1981
INDEXES.
IN TIMES OF ELECTRICAL STORMS, PLEASE UNPLUG YOUR TERMINAL.
ATTENTION TEACHERS:
HAVE YOU HEARD ABOUT THE SPECIAL JOB MATCHING PROGRAM FOR TEACHERS.
APPLICATION FORMS ARE AVAILABLE THROUGH SCOIS.

WOULD YOU LIKE TO
1 - EXECUTE COIN (PROVIDES INFORMATION ON CAREERS: OCCUPATIONS, POST
SECONDARY SCHOOLS, APPRENTICESHIP PROGRAMS, ETC.)
2 - EXECUTE JOBANK (PROVIDES INFORMATION ON JOBS CURRENTLY AVAILABLE IN
SOUTH CAROLINA THROUGH THE SOUTH CAROLINA EMPLOYMENT
SECURITY COMMISSION'S JOB SERVICE)
3 - END THIS SESSION (LOGOUT)
ENTER THE NUMBER OF YOUR CHOICE: 1

Look at your terminal. Is your terminal at:

1. Dec-writer LA36
2. Dec-scope VT52 or VT100
3. any other type

292 Occupational Information

Please enter a digit 1 through 3:1

Welcome to the

COORDINATED OCCUPATIONAL INFORMATION NETWORK

© Copyright 1979, COIN Inc.

Press return to continue and after each frame.

Would you like to:

1. Take a COIN Occupational search
2. Take a COIN Occupational QUICKSEARCH
3. Look at specific COIN Information

Please enter a 1, 2 or 3:1

Do you wish a full description of each search route?

Please enter Yes or No:Y

The COIN Occupational search covers 7 areas:

Interests are defined in terms of worker's preference for certain types of Job activities.

Working Conditions are defined in terms of the physical surroundings in which workers perform their Job tasks.

Career Clusters are defined in terms of the broad career fields in which persons may be employed.

Education levels are defined in terms of the normal training necessary to enter an occupation.

Physical Strengths are defined in terms of the lifting activities workers must perform.

Physical Demands are defined in terms of the physical activities related to performing certain Job duties.

Salary ranges are defined in terms of the average yearly income for persons currently employed in specific occupations.

The seven basic routes are thus:

1. Interests
2. Working Conditions
3. Career Cluster
4. Education
5. Physical Strength
6. Physical Demands
7. Salary Range

Please enter the digit of the route you would like to take first:1

Occupations can be classified by those that primarily involve:

- D. Data
- P. People
- T. Things

Please enter the letter of your interest:Y

You had 309 COIN Occupational Descriptions and now have 216.

Do you wish to search further?

Please enter Yes or No or if yes, the next route number:2

Occupations can be divided into those that involve working:

- I. primarily Inside
- O. primarily Outside
- B. about an equal amount of Both inside and outside

Please enter the letter of your choice of working conditions:8

You had 216 COIN Occupational Descriptions and now have 72.

Do you wish to search further?

Please enter Yes or No or if yes, the next route number:3

Occupations can be divided into the following clusters:

- M. Manufacturing Occupations
- B. Business & Office Occupations
- P. Personal Service Occupations
- E. Education Occupations
- L. Sales Occupations
- C. Construction Occupations
- T. Transportation Occupations
- A. Agricultural Occupations
- R. Repairs & Mechanics
- H. Health Occupations
- S. Social Science Occupations
- D. Design, Communications & Art Occupations
- N. Science & Technical Occupations

Please enter the letter of your choice of career cluster:10

You had 72 COIN Occupational Descriptions and now have 12.

Do you wish to search further?

Please enter Yes or No or if yes, the next route number:4

Occupations may be classified by the amount of education required for entry:

- L. (Lowest) does not require a high school diploma
- O. requires On-the-Job training
- D. requires high school Diploma or GED
- V. requires a high school diploma with specific Vocational classes
- T. requires Junior, Technical, or community college
- A. requires training in an Apprenticeship program
- B. requires a Bachelor's degree
- M. requires a Master's degree
- P. requires a Professional or Ph.D. degree

Please enter the letters of the education you are willing to take:10H

You had 12 COIN Occupational Descriptions and now have 12.

Do you wish to search further?

Please enter Yes or No or if yes, the next route number:7

Occupations can be classified by the average amount of salary they receive:

- A. \$5000 - \$8999
- B. \$9000 - \$12,999
- C. \$13,000 - \$16,999
- D. \$17,000 - \$20,999
- E. \$21,000 - \$24,999
- F. \$25,000 and over

Please enter the letter of your salary range:10

294 Occupational Information

You had 12 COIN Occupational Descriptions and now have 4.

Do you wish to search further?

Please enter Yes or No or if yes, the next route number:IN

Do you wish to see a list of the COIN Occupational Descriptions?

Please enter Yes or No:Y

The following COIN Occupational Descriptions match your COIN Profile:

COIN #	Occ Description	COIN #	Occ Description
5	AGRICULTURAL SCIENTIST	32	BOTANIST
50	CIVIL ENGINEER	84	ECOLOGIST

Are there any COIN Occupational Descriptions that are not on the list that you think should be?

Please enter Yes, No, or the missing COIN Occupational Description number:IN

Do you want to begin another search?

Please enter Yes or No:IN

Would you like to:

1. Look at your list from the COIN Occupational Search
2. Explore a COIN Occupational Description
3. Look at other COIN information

Please enter the digit 1, 2, or 3:2

Look at your INDEX and enter the number of the COIN Occupational Description you wish to investigate:84

COIN Occupational Description # 84 - ECOLOGIST

Ecologists study the relationships between organisms and their environments to determine how plants and animals are affected by their surroundings, and vice versa.

Occupational Specialties included are:

041.061-038	Plant Ecologist
041.061-090	Animal Ecologist
040.061-030	Forest Ecologist

Related COIN Information:

College Major # 135

Related COIN Occupational Descriptions:

#32 Botanist (11-12-A)	#110 Forester (21-9-A)
#104 Fish & Wildlife Spec (14-1-A)	#146 Life Scientist (15-4-A)

Do you wish to see more information about COIN Occupational Description # 84?

Please enter Yes or No:Y

What other occupational information would you like to see?

- A. COIN Occupational profile
- B. Nature of the occupation
- C. Definitions of the occupational specialties
- D. Working conditions, requirements, and methods of entry
- E. Earnings and advancement
- F. Employment and outlook
- G. Other local information
- H. Sources of additional information

- I. none of the above
J. all of the above

Please enter all of the letters for the types of occupational information you wish to see:

88 Profile for COIN Occupational Description 8 84 88
ECOLOGIST

Interest Cluster	Base Things
Career Cluster	Agricultural; Science & Technology
Physical Strengths	Light
Physical Abilities	Climb/Balance;
that are NOT required	Talk/Hear
Working Conditions	Both
Minimum Educational	Bachelor's;
Levels	Master's
Earnings (yearly average)	\$17,000 - \$20,999

88 Nature of COIN Occupational Description 8 84 88

Duties may include, but are not limited to the following:

- Studying the classification of different species
- Determining the conditions which account for the existence of species in different areas
- Studying such factors as rainfall, temperature, sunlight, soil, altitude, plant and animal diseases, and their effects on the distribution and types of plants and animals in an area
- Investigating the ability of different species to adapt to new environmental conditions, such as changes in soil and climate
- Studying air, soil, and water pollution
- Suggesting ways of preserving and protecting plants, animals and their natural habitat
- Performing research

Tools, Equipment, and Materials used may include:

- | | |
|------------------------------|-------------------------|
| Laboratory Testing Equipment | Computers |
| Microscopes | Weather Instruments |
| Binoculars | Reference Materials |
| Cameras | Cars, Trucks, and Boats |
| Calculators | |

88 Occupational Specialties for COIN Occupational Description 8 84 88

Plant Ecologists (041.061-038) study the relationships between plants and their environments.

Animal Ecologists (041.061-090) study the relationships between animals and their environments.

Forest Ecologists (040.061-030) conduct research in environmental factors affecting forests to determine what conditions account for the prevalence of different varieties of trees.

88 Working Conditions for COIN Occupational Description 8 84 88

Ecologists may work alone or as a member of a team under the direction or supervision of a research director or a more experienced ecologist. They may work indoors in clean, well-lighted, well-ventilated offices, laboratories, and classrooms, or on location conducting field research and collecting specimens.

Ecologists generally work a standard 3-day, 40-hour week. Overtime may be required to meet deadlines or complete a project.

Ecologists may travel extensively when on field trips.

Ecologists may join associations such as the Ecological Society of America or the National Wildlife Federation. Members usually pay dues.

88 Worker Requirements for COIN Occupational Description 8 84 88

You Should Like:

- Working with things and objects
- Performing work of a scientific and technical nature
- Working on a problem until a solution is found

296 Occupational Information

You Could Be Able To:

- Perform a variety of duties which may often change
- Evaluate information using personal judgment or measurable standards
- Work within precise limits or standards of accuracy
- Deal with other people

Physically You Must:

- Stand, kneel, crouch, and crawl
- Reach, handle, finger, and feel objects
- See well, either naturally or with correction

Opportunities For Experience:

Part-time or summer employment at experimental field stations, as well as association with civic organizations aimed at cleaning up polluted areas, offer opportunities for experience.

SS Methods of entry for COIN Occupational Description # 84 88

Methods of entering this occupation include direct application and civil service exams. Positions may also be located by consulting newspaper want ads, professional journals, college placement offices, and your state employment office.

SS Earnings & Advancements for COIN Occupational Description # 84 88

Earnings depend upon the employer, geographic location, and employee's level of responsibility, education, and type of work performed.

Earnings:

Nationally, in 1980, Ecologists employed by the federal government earned starting salaries ranging from \$11,243 to \$14,618 a year. Experienced ecologists and those with master's degrees, earned \$17,035 to \$26,794 annually.

Fringe Benefits:

Depending on the employer, Ecologists may receive paid vacations and holidays; life, accident, hospitalization, and disability insurance; retirement plans; and sick pay. These benefits are usually paid for, at least in part, by the employer.

SS Local Earnings Info for COIN Occupational Description # 84 88

IN SOUTH CAROLINA ECOLOGISTS EMPLOYED BY THE STATE EARNED BETWEEN \$12,100 AND \$27,400 ANNUALLY IN 1979.

SS Employment & Outlook for COIN Occupational Description # 84 88

Employment of Ecologists is expected to grow rapidly through the next decade because of public awareness of the need for the conservation of natural resources and increasing concern over pollution. Positions will also be available for ecologically-trained curators and interpretive guides in nature museums and camps, nature preserves, and state and national parks.

SS Local Employment Info for COIN Occupational Description # 84 88

EMPLOYMENT IN THE ECOLOGICAL LIFE SCIENCES WILL GROW AS A RESULT OF INCREASED INTEREST IN PRESERVING THE NATURAL ENVIRONMENT. OPPORTUNITIES FOR LIFE SCIENTISTS ARE EXPECTED TO BE GOOD FOR THOSE WITH ADVANCED DEGREES THROUGH THE MID-1990'S, BUT THOSE WITH LESSER DEGREES MAY EXPERIENCE COMPETITION FOR AVAILABLE JOBS.

SS Other Local Info for COIN Occupational Description # 84 88

Contact your state employment service

SS Sources of Additional Information for COIN Occupational Description # 84 88

Ecological Society of
America
Library 3131
The Evergreen State College
Olympia, WA 98505

National Wildlife
Federation
1412 14th Street, N.W.
Washington, DC 20034

The Botanical Society of
America
New York Botanical Garden
Bronx, NY 10458

College or University
Placement Offices

Federal, State, or Local
Civil Service Offices

Would you like to look at the education and training information
related to this COIN Occupational Description?

Please enter Yes or No:Y

Coin Occupational Description # 84 - ECOLOGIST

Listed below are 9 general levels of education and training. Those levels
preceded by one star are available for entry into this field;
those preceded by two stars are usually required.

- | | |
|-------------------------|-------------------------------|
| 1 Less than High School | 5 Community College |
| 2 On-the-Job Training | 6 Apprenticeship |
| 3 H.S. Diploma or GED | 7 College-Bachelors Degree |
| 4 H.S. including Voc Ed | 8 College-Masters Degree |
| | 9 College Professional Degree |

What kind of related educational information would you like to see?

1. School Subjects
2. College Majors
3. Apprenticeship Programs
4. Military Training Opportunities
5. none of the above

Please enter a digit 1 through 5:1

SCHOOL SUBJECTS

The following school subjects are helpful in preparing for
occupations covered in COIN Occupational Description # 84:
ECOLOGIST

COIN # Subject

2	Agricultural Production/Management
3	Agricultural Resources
5	Forestry
8	College Preparatory
16	English
20	Speech
35	Algebra
40	Statistics
56	Biology
57	Chemistry
59	General Science
61	Physics
62	Economics
68	Political Science

What kind of related educational information would you like to see?

1. School Subjects
2. College Majors
3. Apprenticeship Programs
4. Military Training Opportunities
5. none of the above

Please enter a digit 1 through 5:2

COIN COLLEGE MAJOR # 135:
Ecology

Related COIN Occupational Description:
#4 ECOLOGIST (13-5-A)

The purpose of programs in ecology is to provide opportunities needed to identify, evaluate, and solve contemporary environmental problems. Ecologists may pursue careers in government, industry, and education in such areas as environmental resource planning, public health, and teaching.

Courses within this Major will vary from school to school, but may include:

Problems in Environmental Quality	Environmental Systems Under Stress
Culture in Environment	Energy, Entropy, and Environment
Environmental Geology	Energy and Man
Environmental Biogeography	Practicum in Environmental Problems
Environmental Psychology	

Would you like to see which Post-Secondary Schools offer this major?

Please enter Yes or No:Y

The number of schools that offer COIN College Major number 135 in each region is as follows:

1. 29 in the Pacific and Mountain States
2. 19 in the North Central States
3. 29 in the Great Lakes States
4. 13 in the South Central States
5. 18 in the South Atlantic States
6. 24 in the Middle Atlantic States
7. 24 in the New England States

In which region of the country do you wish to search?

Please enter a digit 1 through 7:5

In which state(s) of the South Atlantic region do you wish to search?

- A. Delaware
- B. District of Columbia
- C. Florida
- D. Georgia
- E. Maryland
- F. North Carolina
- G. South Carolina
- H. Virginia
- I. West Virginia

Please enter the appropriate letter(s):H

The number of schools that qualify is 1

Do you wish to search further?

Please enter Yes or No:Y

Would you like

1. a list of the schools that qualify
2. to start the COIN School search again
3. neither of the above

Please enter the digit 1, 2, or 3:1

The following schools fit your requirements:

3106 Ferrus C VA

Would you like information about any of these schools?

Please enter Yes, No, or the COIN School number:Y

Please enter the COIN number of the school: 3106

Select the types of information which interest you:

1. General Information
2. Cost and Financial Aid
3. Admissions Information
4. College Majors offered
5. none of the above
6. all of the above

Please enter your selection(s): 6

FERRUM COLLEGE

FERRUM

VA 24088

School Number: 3106

Type: 4-year

Fiche: 110-5-C

Affiliation: Methodist

General Information

Degrees/Programs Offered:

Career oriented: NO
Associate degree: YES
Baccalaureate degree: YES
Master's degree: NO
First Prof. degree: NO
Ph.D. or equivalent: NO
Other: NO

Calendar: Early Semester

Enrollment (full time): 1500

Student Body Composition:

% undergraduates: 100
% graduates: 0
% minorities: 12
% women: 40

Community

Size: Small Town

Type: Rural

Undergraduate Programs (Special):

Sororities/Fraternities: NO
with residences: NO
Work-Study program: YES
Foreign study: YES
Summer session: YES

ROTC required: NO

Air Force ROTC available: NO

Army ROTC available: NO

Navy ROTC available: NO

COIN School Number: 3106 - Ferrum C

Cost & Financial Aid

Undergraduate Costs:

Tuition & Fees:
Resident: \$ 3490
Out of district: \$ 3490
Out of state: \$ 3490
Room & Board:
Available through sch: NO
Required for Freshmen: YES
Cost (average): \$
Total (average): \$ 3490

Financial Aid for Freshmen:

Financial aid deadline? YES
Fall application deadline: 1 May
Date aid usually exhausted: 1 Jun
"Financial Need" form required:
FFS or FAF/SFS usually accepted
% having need receiving some aid: 35
% having need receiving full aid: 0
Service to help find work: YES
% Freshmen employed during sch year: 30

COIN School Number: 3106 - Ferrum C

Admissions

Students Accepted:

Freshmen: YES
Local: YES
Women only: NO
Men only: NO
Sophomore students: YES
Upper division: YES
Graduate students: NO

Fall application deadline for Freshmen:

Freshmen admission policy:
Liberal

Tests required or desired for admissions:
ACT or SAT

Freshmen Admissions/Placement:

Fall admissions only: NO
Early admissions: YES
Deferred admissions: YES
CRDA-candidates reinv: NO
Remedial skills courses: YES
Honors courses: YES
Credit by examination: YES
Advanced placement: YES
Independent study: YES

Freshmen Class Profile:

Mean ACT Composite: 16.0
Mean SAT Verbal: 380
Mean SAT Math: 400
High School Percentile: 80.0
Grade Point Average (A=4.00):
High School: 2.45
First-year College:

300 Occupational Information

College Number 3106 - Ferrus C

offers the following majors and/or career oriented programs:

- | | |
|----------------------------|---------------------------|
| 1 Agriculture, General | 13 Business/Commerce, Gen |
| 14 Accounting | 17 Business Mgmt & Admin |
| 21 Office Management | 25 Secretarial Studies |
| 31 Education, General | 38 Technical Ed/Ind. Ed |
| 54 Envirn/Ecological Eng | 56 Industrial/Mgmt. Eng. |
| 57 Mechanical Engineering | 119 Religion |
| 120 Speech/Debate/Frnc Sci | 121 Mathematics, Gen |
| 122 Applied Math | 131 Biological Sci, Gen |
| 132 Biology | 134 Botany |
| 135 Ecology | 136 Microbiology |
| 137 Zoology | 140 Chemistry |
| 144 Law Enforc/Corrections | 149 Social Work |

Would you like information about any other COIN School?

Please enter Yes, No, or the COIN School Number: N

Would you like to search for a different list of schools?

Please enter Yes or No: N

What kind of related educational information would you like to see?

1. School Subjects
2. College Majors
3. Apprenticeship Programs
4. Military Training Opportunities
5. none of the above

Please enter a digit 1 through 5: 5

The Environmental Protection Careers Guidebook

**Jules Spector
U.S. Department of Labor
Washington, D.C.**

INTRODUCTION

Concern for the quality of the air we breathe and the water we drink are reflections of changed attitudes about ourselves and our environment. This concern is reflected in the many changes which are seen in occupations relating to environmental protection.

The Environmental Protection Careers Guidebook, a publication developed as a major counseling and guidance document by the United States Department of Labor and the United States Environmental Protection Agency was made available to the public in February, 1981. It fully reflects the many changes and opportunities found in the field of environmental protection. This document describes, in detail, 106 occupations that have resulted from the growing interest in environmental protection. Many of the occupations included in the Guidebook have never been described before, and a number are clearly described for the first time. In addition to describing the tasks and responsibilities of each of the 106 occupations, complete information is given on education and training requirements for each occupation, as well as the prospects for employment.

Covers Seven Fields

Most of the occupations described are in one of seven environmental fields: water and wastewater treatment; noise control; air resource management; land, fish, and wildlife management; pesticides and toxic substances programs; solid waste management; and radiation control.

In addition to detailing the major responsibilities of workers in these fields, pertinent information is given on places of employment, areas of specialization, and the particular worker characteristics helpful to effective performance. Also presented are licensing and certification requirements.

A review of some of the occupations described demonstrates the extensive occupational coverage of the publication.

Water and Wastewater Treatment: Chemist, Water Purification; Supervisor, Waterworks; Water-Filter Cleaner; Industrial Waste Inspector; Microbiologist; Treatment-Plant Mechanic; TV Technician, Wastewater Collection; and Ditch Rider.

Noise Control: Audiologist; Audiometrist; Noise Engineer; Noise Specialist; and Noise Technician.

Air Resource Management: Air Chemist; Air Engineer; Air Scientist; Air Technician; Air Technician, Meteorology; and Biometrician.

Land, Fish, and Wildlife Management: Conservation Officer; Fish Biologist; Forester; Land Planner; Park Ranger; and Wildlife Biologist.

Pesticides and Toxic Substances: Agricultural Chemicals Inspector; Agricultural Pest Control Specialist; Entomologist; Entomology Field Assistant; Environmental Epidemiologist; Industrial Hygiene Chemist; Pesticide Use Medical Coordinator; Toxicologist; and Vector Control Assistant.

Solid Waste Management: Refuse Collection Superintendent; Resource Recovery Engineer; Sanitation Inspector; Waste Management Engineer; and Waste Management Specialist.

Radiation Control: Chemical Radiation Technician; Emergency Services Radiation Coordinator; Health Physicist; Radiation Laboratory Technician; Radiation Protection Engineer; and Radiological Instrument Technician.

Other Environmental Activities: Chemical-Laboratory Technician; Engineering Aide; Engineering Technician; Environmental Economist; Environmental Lawyer; Industrial Hygiene Engineer; Laboratory Aide; Occupational Health Nurse; and Physician.

Educational Aspects

The Environmental Protection Careers Guidebook deals extensively with the education aspects of entrance into the field. An extensive list of Postsecondary Environmental Education Programs is included, both by type of Pollution area and by State. This list is the most extensive published to date.

Also included in the Appendix is a presentation on environmental legislation and financial and technical assistance.

A glossary of 53 terms specific to environmental protection is included, providing the user with the definition of such terms as: Bioassay; BOD, or Biochemical Oxygen Demand; Dosimeter; Sand Filters; Tertiary Treatment; and Vector.

New Occupations "Discovered"

The "discovery" of a large number of new environmental protection occupations, a byproduct of the development of the Guidebook was less of a chance factor than it would seem. In development of the publication reliance was placed on available resources relating to environmental protection and particularly the EPA's expertise in performing job analysis studies in the field was utilized. Through this process of analysis, utilized by the U.S. Employment Service of the Department of Labor, all areas relevant to the universe of environmental protection were covered. Where a new occupation came to light, a complete, on-site job analysis was made of all the tasks and related factors of that occupation. This information was incorporated into a Job Analysis Report which will also serve as resource for future editions of the Department's Dictionary of Occupational Titles. At the same time the information was developed into a narrative format for incorporation into the Guidebook. The descriptions of the environmental protection occupations, including the newly incorporated materials, have an importance which extends beyond the counseling and guidance design of the Guidebook. Because of the extensive information not elsewhere available, the Guidebook serves an important function in areas of legislation, staffing programs, educational program development, and the overall employment process. Researchers will find the publication a unique source of information on both occupations and the universe in which they occur. Through the Guidebook the field of environmental protection can be measured and examined with a completeness not before possible.

Copies of the 205-page, Environmental Protection Careers Guidebook, can be obtained for \$6.50 per copy (Stock No. 029-014-00205-4), from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

Secondary School Utilization of Community Colleges as a Learning Resource Center

**Jerry L. Smith
Charles County Community College
La Plata, Maryland**

INTRODUCTION

The energy crisis of the seventies has brought many changes to the American scene. The American educational system has not been spared from these changes. As the cost of fuel becomes a major factor in daily decision-making, so does energy cost become a factor in the choice of universities, colleges and technical schools that commuting students may attend.

The axial concept of the community college developed in the sixties and seventies, has taken on new dimensions in this decade. To develop ways that will educate the public as to the resources available on a local basis.

One such method is to provide a service or need that will "draw" the public to the college. This is opposed to the "recruitment technique" that requires many hours of personnel time, travel expense and may reach a relatively small number of people. The following program was developed by the Charles County Community College's Pollution Abatement Technology Division to educate the general public of facilities in the Division and to increase its role in the education complex of the County. The College has offered its resources, both instructional and physical to the development of high school age, gifted and talented students. Through the coordination of the high school science program and the College, many young minds have been motivated and challenged into scientific

careers. Based on previous experience the following suggestions might be instrumental in helping initiate a cooperative program.

Program Initiation

- Invite the area high school science *teachers* onto the campus.
- Familiarize the *teachers* with the instructional staff and their areas of expertise.
- Develop a list of the physical equipment at the College's disposal, what it can and cannot do, and a practical overview on how it works, including time requirements for such procedures as standardization and development of calibration curves.
- Encourage *teachers* to have their students draft a written outline of the research to be done. Included should be a hypothesis, a step-by-step explanation of the procedures to be followed, equipment and materials to be needed, a time frame for each phase and literary research to be completed prior to the actual commencement of the experiment.
- Contact the science department in the proper field and set up an appointment between the *teacher*, student and one of the instructors. During the meeting the instructor will advise the *teacher* and the student what role the College may play in the project.
- A schedule will be drawn up that will allow time that is mutually convenient for *teacher*, student and instructor.

Teachers should be informed that they must "always" accompany the student except when it has been mutually agreed upon by the *teacher* and instructor. Liability requires that an adult be present during any experiment. The demands and responsibilities of an instructional staff seldom will permit their continual presence.

Objectives of the Program

The overall objective of the program is to familiarize the community, schools and student body with the potentials of a scientific career. Specific objectives are:

- to introduce *high school faculties* to the opportunities that exist at community colleges
- to provide expertise and advisement to gifted and talented students
- to develop rapport between *secondary and collegiate personnel*

- to provide contact between student and the scientific community
- to expose students to college life and opportunities
- to increase awareness between college and *high school personnel* as to the curriculum and needs of each institution
- to help coordinate student transition from high school to college academics

Program Description

It is requested that the *teacher* accompany the student at every visit. As a student works in a college laboratory, it has been found that many of their questions can be more easily answered by their *teacher*, who is more familiar with the student's previous background than is the college instructor. Instruction and explanations of various aspects of theory are quickly and easily assimilated by the *teacher* who may then exploit his rapport with the student to develop the desired goals. This helps maintain student confidence levels in their classroom *teacher* while providing a new resource for the *teacher*.

Introduction to sophisticated equipment and techniques, as is available at the college, may proceed at the rate perceived by the *classroom teacher*. As the *classroom teacher* gains confidence in instrumentation and procedures, other students may be incorporated into the program without the concern of overtaxing college instructional personnel. The degree of sophistication of experiments and equipment are only limited by the ability level of the student and the time limitations of the *classroom teacher* and instructor.

Selection of Students

Selection of students participating in the program is two-fold. The *classroom teacher* must keep in mind the vigorous academic program that would be expected of participating students, and selection should be based on previous records and experience indicating the desired achievement levels.

The college instructor will base his selection on what he feels the student will need as a subject base or background to be successful in his or her project.

Numbers of Students Participating

The number of students participating in the early phase of the program would, out of practical considerations, be small. As the *classroom teacher* plays an increasingly important role

in the actual supervision of research, the college instructor could assume strictly an advisory role. The knowledge gained by both *teachers* and students in this program would eventually trickle back into the secondary classroom to the benefit of more students than could actually be incorporated in the college program.

Cost in Time in Materials

It has been the college's experience that most programs do not involve significant expenditures. Careful review of the drafted research proposal will indicate costs, and if they are excessive, the student will have to be asked if he or she wishes to continue the research at their own expense.

Time factors are a serious limiting factor in the scope of this project. It is for this reason, as well as others mentioned above, that the *classroom teacher* must accompany the student. As the teacher becomes more experienced, the breadth and scope of the program may increase proportionally. College instructional time decreases on a per student basis as the program gains experience and longevity.

Evaluation of the Program

Long term evaluation cannot be accomplished until the student records of academic achievement and career choices can be ascertained.

Short term objectives are immediately apparent. Immediate rise in student enrollment is noted with a direct correlation between involved schools, *cooperating teachers* and students in the program. Intangible results such as public image, parent and community awareness are less readily measured but appear to be significant. Improved curricula and teacher backgrounds are inevitable though indirect results.

SUMMARY

In a decade of decreasing young population, enrollments and public tax support, institutions with innovative approaches will not only survive, but grow and prosper. Cooperative programs with high schools offer a unique opportunity to help our emerging generations to make career choices and obtain successes that might otherwise be left to chance. The future belongs to those who are not hesitant to mold it.

The Effective Partnership of Guidance and Work-Related Education and Training

Harry N. Drier
President, National Vocational Guidance
Association and Associate Director, National
Center for Research in Vocational Education
The Ohio State University
Columbus, Ohio

INTRODUCTION

Over the past 80 years, our country has undergone substantial change in its occupational, social, and economic structure. Occupational and industrial specialization have increased dramatically. Social structures and social values have changed, becoming more complex and diverse. New and emerging social groups have challenged established groups, demanding equality. People have been on the move, too, from rural to urban areas and back again and from one region of the country to another in search of economic and psychological security.

Guidance: Meeting Needs for 80 Years

As these changes and others were taking place in our society, many organizations and groups of interested and involved citizens established programs and services at national, state, and local levels to help individuals deal effectively with them. Within the educational community, Guidance and Educational personnel have been and continue to be in the forefront of providing such programs and services. Guidance personnel in particular have played key roles in

responding to individual and societal needs in times of change. Here are just a few examples:

- In the early 1900's, industrialization was increasing rapidly. Mass immigration was taking place as was urbanization. Schools were highly academic in orientation. Little attention was given to providing occupational skills and even less attention was given to helping individuals make the school-to-work transition. In response to these conditions, guidance personnel joined with vocational education personnel to change education to make it more related to life and work. Guidance techniques were developed to assist individuals in the transition from school to work.
- In the 1920's and the 1930's extensive work was done to improve the nature and availability of career information. The National Vocational Guidance Association, founded in 1913, established guidelines for quality career information and has subsequently sought to improve the development and dissemination of such information over the ensuing years. Extensive work by professionals in and out of government service in the 1930's and 1940's led to the establishment of many of the career information resources available today.
- During World Wars I and II, substantial work was done in aptitude and ability assessment. After each of the World Wars, but particularly World War II, extensive guidance programming was provided to assist returning veterans to take up their lives once again to start afresh. This also was true during the Korean and Vietnam conflicts.
- In the late 1950's widespread concern was again expressed about the adequacy of our educational system, particularly in science and engineering technology. Again, guidance personnel were called upon to take on a major role in responding to this social mandate.
- During the 1960's and 1970's, social activism escalated. Social programs of many kinds were initiated. Unemployment and underemployment were of particular concern. Guidance programming including assessment, counseling, career information, placement, follow-up, and follow-through activities was seen by many groups, including the Federal government, as a highly legitimate tool in assisting individuals to find

employment, stay on the job, and advance in the work world.

This chronology, though brief, illustrates vividly that guidance has been and continues to be a major social program that assists individuals in dealing effectively with their lifelong development including occupational choice and job adjustment. It also is important to realize that the past eighty years have witnessed substantial improvement in the nature, structure, practice, and effectiveness of guidance, partly because of how counselors and other guidance personnel responded to changes in the structure of American society, and partly because of the research and development work of the guidance and counseling profession as a whole.

The Providers, Settings, and Expectations of Guidance Programs

Guidance has become a major endeavor and element of our nation's educational, employment, training, and numerous community agencies. Systematic and development programs of guidance and in some agencies, counseling programs, serve as the common link between providing occupational training and employment readiness for the eventual transition to and satisfaction in the work place. Guidance programs are operating to varying degrees of completeness in a wide variety of settings. At the secondary level, guidance and career development instructional providers are represented in public and private comprehensive and vocational high schools. At the postsecondary level, vocational programs including guidance are offered by colleges and universities, community and junior colleges, area vocational schools, public and private non-collegiate postsecondary schools, correspondence schools, and correctional facilities, to mention a few. In addition, thousands of professional counselors and guidance personnel are employed through the Department of Labor's Comprehensive Employment and Training Act (CETA) and by the Employment Service, with offices in the majority of the nation's cities. Table 1 profiles both the type and number of agencies nationally as well as the approximate number of enrollment or clients being served.

Within each of these institutions or agencies professional counselors and a variety of guidance specialists and support staff provide guidance program leadership and services. Table 1 reflects the approximate numbers of staff that typically are

Table 1

Settings	Number of Institutions	Enrollments	Counselors and Guidance Specialists
1a. Public Secondary Schools (combination of grades 7-12)	15,729	13,711,000	61,650
1b. Public and Private Secondary Schools (those that provide vocational training) (1978)	5,560		19,896
2. Private Secondary Schools	586	1,400,000	1,220
3. Junior and Middle Schools (public and private)	Covered in 1 & 5	Covered in 1 & 5	9,700
4. Elementary Schools (public and private) (1977)	61,123 public 11,352 private	31,819,000	9,400
5. 2-Year Public Institutions of Higher Education (1978)	975	3,913,000	unknown
6. 4-Year Public Institutions of Higher Education (1978)	561	8,980,000	unknown
7. 2-Year Private Institutions of Higher Education (1978)	249	166,000	unknown
8. 4-Year Private Institutions of Higher Education (1977)	1,395	2,507,000	unknown
9. Public Junior College Postsecondary Schools (1977)	1,955	766,865	unknown
10. Private Junior College Postsecondary Schools (1978)	7,382	997,196	unknown
11. Correspondence Schools (private and public) (1975)	106	614,124	unknown
12. State Correctional Facilities (those that provide vocational training) (1979)	553	330,887	***
13. CETA Prime Sponsors (1980)	476	3,100,000	unknown
14. Job Service Offices (1979)	2,600	17,000,000*	5,113**
15. Educable Mentally Retarded (1970)	Covered in 1, 2, 3, & 4	Covered in 1, 2, 3, & 4	7,689
16. Area Vocational Schools	1,089	575,000	1,500

Note: Total number of enrollments in vocational programs, 16,704,926 (1978) USOE. Most other figures are best approximations.

* 1,130,000 clients actually received counseling.

** 4,313 full-time, 800 part-time.

*** Counselors are included along with treatment and educational specialists. 6,319 (1974).

available as well as the numbers of clients that require or request guidance and counseling assistance. While the data provided suggests that there is a range of guidance staff available, there is striking evidence to suggest it is not sufficient. One major problem that occurs is the uneven distribution of staff availability in certain settings. As an example, if one were to view the staffing profile and the availability of guidance programs in our nation's 7,000 rural and isolated schools, there would be cause for alarm. It is estimated that in these locations, less than 10 percent of elementary students have access to guidance programs, while at the junior high and high school level less than 40 to 50 percent of these students have access to guidance programs. Furthermore, the staff are often only part-time employees and have little or no budgets specifically for guidance.

In some of our largest states and cities the counselor-student ratios in public schools also is much less than the American Personnel and Guidance Association recommended ratio of one counselor for every 250 students. In a large Midwestern state the ratio at the high school level is 1 to 630. Combining the ratios of four of the ten largest cities in the country, they would approximate 1 to 740. Additional examples of inadequacy of staff, program, and resources could be cited in correctional settings, and in a variety of community agencies. When one parallels these facts with the increasing needs of youth and adults who are facing deficiencies in the most basic of skills, dropping out of education before they are prepared, unemployed, lack employability skills and access to training and work opportunities, it is clear that improved guidance delivery is needed. Guidance programs can be responsive to society's problems and the needs of clients only if they are available on an equitable basis, fully staffed with a competent set of professional and paraprofessional staff.

In addition to gaining an understanding of who the providers are and where they work, it also is important to appreciate the primary emphases of their programs. Table 2 depicts these emphases in a sample of nine different settings. Because many skills need to be developmentally learned over many years, it is noted that many of the basic skills and attitudes are taught at all or most age levels. This demonstrates the need for a developmental approach to meeting certain client competency needs as they take on different characteristics over time.

In summary, it is important to note that these program emphases have proven to be most important in meeting many of

Table 2

	Age Level	Self-Assessment	Self-Concept	Career Decisions	Career Planning	Career Awareness	Career Exploration	Work Experience	Employability	Coping with Work	Economic Realism	Work Options	Training Options	Job Placement	Follow-through	Job Progression	Special Transitions
1. Elementary Schools	Age 6 to 12	●	●	●	●	●					●	●					
2. Junior and Middle Schools	Age 12 and up	●	●	●	●		●				●	●	●				
3. Secondary Schools	Age 14 and up		●	●	●		●	●	●	●		●	●	●	●		
4. 2 Year Postsecondary Schools	Age 18 and up			●	●			●	●	●		●		●	●	●	
5. 4 Year Institutions of Higher Education	Age 18 and up			●	●			●	●	●		●		●	●	●	
6. Correctional Institutions	Age 14 and up		●	●	●				●	●		●	●	●	●		●
7. CETA	Age 16 and up	●	●	●	●	●	●	●	●	●		●	●	●	●		●
8. Job Service	Age 16 and up	●	●	●	●				●	●		●	●	●	●		●
9. Educable Mentally Retarded	Age 6 and up	●	●			●	●	●	●	●	●	●		●	●		●

the major problems facing our nation's youth and adults. It has been demonstrated that when individuals develop a healthy self-image, view the future with hope and realism, have the opportunity to test out both educational and work options in a secure environment, they are typically more satisfied with life, and become positive contributors in society.

Work-Related Education and Training: Its Relationship to National Challenges Faced by the Education Community

In our rush toward the rapid solution of massive social challenges—chief among them structural, demand-deficient, and fractional unemployment—it would be easy to fall victim to a dangerous tunnel vision: that a quantifiable increase in the nation's trained workforce will eliminate these problems. History has shown us the cost of such shortsightedness, for it overlooks the essential investments of individual choice, motivation, and perseverance that distinguished the purposeful from the aimless; the productive worker from the alienated laborer; the youth who know themselves, their options and their capacities from those described (by themselves or others) as "out of skill, out of luck, and out of hope."

As this section documents the contributions that planned guidance and counseling programs do and can make to the objectives shared with vocational educators, it does so from a perspective borne out through more than sixty years of experience with vocational programs and those they serve. Briefly, that perspective is this: no adult knowingly becomes fodder for a larger national purpose without some assurance that this participation will yield meaningful personal, social, or economic returns; no youth considering the two or three years needed to acquire a particular job skill should be expected to persist without confirmation that this training has some real connection to known interests and aptitudes, to a job that can be won on the basis of competence—not race, sex, or handicap, and in the words of many youth today, to a job that goes someplace he or she would like to be. It is from this premise that the following data is organized in response to five of the six tasks defined by vocational education. (Note: the goals of equity and service to client groups with special needs are restated as one task.)

Strengthening Depressed Communities (by improving the human condition)

Depressed communities tend to have one or more of the following characteristics: heavy or sparse populations per

square mile, high unemployment, low GNP contribution, little or no "new" industry, a large proportion of resident poor, etc. In such locations, there is evidence that guidance and counseling programs can alleviate some of the symptoms associated with these conditions. In brief, when guidance and counseling programs augment the delivery of services for potential or actual dropouts, delinquents, or others alienated from establishment methods or institutions, recidivism rates are lowered, school attendance increases, educational/career goals are more firmly articulated and pursued, and placement rates increase. Further, when these programs use specific approaches, such as peer counseling by indigenous role models, early and continued employer and parent involvement, employability development through career-oriented instruction—they demonstrate consistently high levels of success.

In a Baltimore project providing counseling and support services, nondelinquent youth were matched by age and background to predelinquent and potentially delinquent children. It was found that in comparison to a control group, those exposed to this program had a lower rate of recidivism for truancy, runaway, and ungovernability.²¹

Male (N = 321) and female (N = 23) offenders enrolled in adult basic education, general educational development and vocational courses in eight Pennsylvania correctional institutions concluded that a lack of sufficient counseling services was a problem. They ranked career counseling as number one among seven needed services.²¹

Gibboney and Associates studied the Philadelphia Career Intern Program over its two-year pilot stage.¹⁵ This program was targeted to 250 actual/potential school dropouts and emphasized counseling, career planning, classroom learning and work experience. Three age cohorts were matched with controls to determine treatment effects. Distinctions between the groups were found in school recidivism (85 percent of controls dropped out of school versus 33 percent of program participants) and goal setting; i.e., further education and training after high school were targeted and realized by 30 percent of male participants and 50 percent of female participants.

In one Chicago school district, a counseling program was designed to improve the self-esteem of students in hopes that it would reduce the number of school dropouts that previously had been shown to average 9.2 percent in the secondary school. It was found that as a result of the individual and group counseling in the program there was a significant reduction in the dropout rate. Because of the success of the secondary

school program, a similar but modified counseling approach was instituted in the elementary schools. Among the results were a mean improvement in excess of ten days per semester in attendance, which represented a minimum increase of 4,350 instructional hours for the students involved; 77.4 percent of the pupils improved on a measure of pupil conduct and social adjustment; there was a significant increase in general achievement and in reading among the students involved in the program.⁴

New York City schools have also reported similar findings to Philadelphia in their institution of the Auxiliary Services Program. In this program, counseling, remedial math, and remedial reading, as well as high school equivalency study, were combined to focus on the academic achievement of Title I students who were two or more years below grade level. Students participating in these remedial programs showed statistically significant growth in achievement.⁵

Frisby reports that within the Balance of the State of Maryland (nine counties on the Eastern Shore and three Southern Maryland counties), a total of 373 economically disadvantaged in-school juniors and seniors are receiving employability development training and work experience.¹⁴ The success of these programs has been attributed to the comprehensive guidance services that have supported the "hands-on" work experience. The emphasis on self-concept development, work and personal values, and on job seeking, finding, and keeping skills has resulted in an overall 75 percent placement rate for these "employable" youth. Frisby credits this placement rate to the identification and subsequent reduction of six barriers to employment: poor work habits, lack of occupational information, poor self-concept, unrealistic aspiration levels, lack of adequate role models, and limited exposure to assessment materials normed on similar groups.

Meeting the Nation's Need for (Motivated, Informed, and) Qualified Workers

Qualified workers alone cannot solve this country's work force problems. Motivated, informed, purposeful workers with skill credentials can move more effectively. Documentation that guidance and counseling programs accompanying vocational skill programs render a longer labor market advantage to the graduate persists in the literature. Beneficiaries of this collaboration are more likely to hold onto their jobs, get work

more quickly, transfer job skills and objectives to a larger variety of career fields, and remain more attractive to their employers. It has been further demonstrated that counseled graduates of skill training programs are more flexible, optimistic, and open to learning on the work site.

A program of short-term behavioral intervention with families of delinquent males and females was found to significantly increase family interaction and reduce recidivism.¹

Braden notes two projects in his home state of Kentucky which were designed for high-risk junior high school age youth and for first time offenders, respectively. "Project Succeed" (Louisville) operates as a school within a school and offers a specialized curriculum emphasizing career education and job preparation, intensive home school coordination and guidance and counseling.⁴ Attributed to counseling services were improvements in attendance and reductions in police and court contacts. "Project Way Out" (Jefferson) fills a service gap between probation and group home supervision for juvenile offenders. Counseling effects were reported by employers of 90 percent of these graduates as increased dependability and task completion. Later observations showed these youths as "sharply reducing the incidence of offenses requiring detention with substantial gains measured on attitude and self-concept scales administered on the work site."

Andrisani and Ellwood suggest differential effects upon counseled males and females when brief periods of unemployment followed high school tenure.^{2,12} Unsuccessful males were more able to adjust their expectations downward (to minimum wage or below), apply different job search techniques, or even "hold out" for higher wages if they had worked even briefly during high school. Females, on the other hand, were more likely to cease the job hunt entirely, turning to parenthood or continued education as alternatives. Neither group reported decreased self-confidence or negative attitudes toward work.

Mason has reported a number of studies done in various state offices of the Employment Service focused upon the question: Does counseling help people get jobs? In one study, 10,000 applicants were studied who had received an average of two counseling interviews each during 1972-73 in one of four states: Iowa, Missouri, Utah, or Wisconsin. The study showed that in Missouri and Iowa, the placement rate for counseled applicants was twice that for all applicants serviced. In Missouri, 40 percent of those receiving counseling were placed in jobs compared with only 20 percent of all applicants.²¹

All youth programs established in Orange County, CA reported the need for more counseling, both personal and career. Most barriers to learning and adjustment were found to be non-job skill related. "We need helping adults with the sensitivity and understanding to counsel an alcoholic youngster, a kid who has been busted, or kicked out. These counseling skills are as much in demand as are skills which teach the proper method to hold a hammer, strip a wire, or lay a carpet."²⁷

Lowell, Massachusetts is one of fifteen sites in the U.S. where the job search club method is being tested by the Department of Labor as an alternative to referral of eligibles to traditional CETA programs, skill centers, or to public service employment. Five weeks of intensive counseling and job inquiry techniques are offered to groups of ten to twelve individuals at a cost of \$500 per client vs. \$4,500 a year for welfare payments, or \$10,000 to \$20,000 a year for public service job placement. Placement rates for these participants is currently at the 80 percent level, with an estimated savings to local taxpayers of \$1.5 million.²⁸

*Keeping the (Vocational Education) Program Relevant
(through the provision of comprehensive guidance and
counseling programs)*

No educational program can claim relevance without constant study of its currency with those elcting it. The assurance that guidance and counseling programs will diligently monitor client needs in vocational programs they choose is self-explanatory. One function of an established guidance component is research on current delivery systems: their effectiveness with new target groups, new age groups, new presenting problems. Evidence that the presence of guidance and counseling programs increases the likelihood that vocational education can be more responsive to underserved groups is sampled below.

The special career counseling and information needs of adults have become more and more resistant to the systems and technologies designed primarily for youth. Adult advocates point out that this group has less time and place flexibility, greater amounts of work experience, and fairly well entrenched work habits of either a positive or negative nature. The challenge will be to provide vast amounts of localized vs. national career information, opportunities to unlearn non-productive work behaviors as well as to acquire new job skills—all in settings which do not smack of school or institution based origins.²⁹

Richmond, Buzzell and Denbo, Heelas and Conroy suggest strong guidance elements in vocational programs can counteract the short-lived labor market advantage (about four years) enjoyed by graduates.^{7, 10, 16, 29} Specifically, in those programs where counseling was provided prior to, during, and following training, smaller differences existed between male and female earning power; a trend toward electing continuing training and education was observed; measurable improvements were recorded in assertiveness and self-image, knowledge of job skill transferability.

Appelbaum and Koppel and Stephenson found that work experience during high school tenure, combined with counseling in job interview skills, personal behavior and dress, working with authority figures, and developing job contact networks were significantly associated with securing immediate post high school employment, regardless of vocational skill level.^{8, 31}

In one study a group counseling intervention was combined with teaching materials designed to aid students in improving their career maturity and decision-making skills. High school students, both academic and non-academic in orientation, were involved over a ten-week period. As a result of the program, student reported outcomes were that they now knew more about occupational choices (62%); could go about getting information (73%); could recognize their values and use them in making decisions (76%); consider and rank alternative according to the ones that are best for them (68%); could make career decisions (82%); and, that they could see that their first and second occupational choices made before the program may not be the best for them.¹¹

A review of educational research conducted by a large state school system showed that when career guidance and counseling services were provided in the nine districts studied to a target group of disadvantaged youth identified in each location, 73 percent of these youth completed their education. Their employers imported their entry skills as marketable, but gave higher marks to their academic standing and their personal confidence.¹⁰

Computer-based career guidance systems using experimental and control groups of students have shown that targeted youth make larger gains in planfulness, knowledge of career resources, and the costs and risks associated with these options.²⁵

Meeting the Nation's Equity Goals (through a greater responsiveness to target groups needing special programs and services)

Equity in vocational education training opportunities cannot be guaranteed by edict alone. A long and dedicated history of preparation, re-education, and redirection must characterize orientation to this option for skill development. Prevocational counseling and guidance are as important to this effort as are the initiatives characterized by the groundwork done with employers, other teachers, and parents by guidance staff. The minority youth, the handicapped adult, the female or male seeking nontraditional employment need massive intervention and continued support if vocational education is to be an effective alternative. Evidence that guidance and counseling programs do make a difference in achieving genuine parity of access to work as well as training is being accumulated.

Adolescent black males who have been assisted to decide upon vocational objectives have been found to have more positive self concepts than do those who have not.¹⁹

Adolescent mothers receiving twelve months of concentrated counseling in parenting skills agreed to complete a high school or vocational program in a quid pro quo arrangement. Of this group, 65 percent fulfilled their contracts, with 59 percent of these females electing to continue their education in a college setting.²⁰

Teenage Women in Nontraditional Employment (TWINE) is operated by the Economic Opportunity Board of Clark County, Nevada. TWINE's goal is to familiarize low-income teen-aged mothers with the skills and tools needed in construction trades and home weatherization, prepare them for apprenticeship tests and place them in jobs. So far, the young women have completed four home rehabilitation and weatherization projects. Part way through the project there had been 200 apprenticeship placements, two referrals to other programs, and two "nonpositive" terminations. The most serious problem has been a lack of in depth counseling to overcome the doubts many young women have about their abilities to handle construction jobs. Also, program officials note, many women lose interest in construction jobs when they get firsthand experience of the actual working conditions.

Kane and Frazee surveyed a national sample of females (N=3,070) enrolled in nontraditional occupational courses in area vocational schools to determine what factors contributed to their choice, persistence, and future plans. Counselors were

identified as second only to "mothers" as the most influential support system by these young women.¹⁶

Lennon reports on six federally-funded programs located in Columbia, Missouri; Westport, Connecticut; Portland, Oregon; Fullerton, California; Syosset, New York; St. Paul, Minnesota. Each focuses on either the handicapped, disadvantaged, or dropout prone youth of high school age, but all programs are characterized by counselor coordination and management. Final reports issued showed significant gains by participants in areas of school attendance, achievement, socialization, and career planning skills.¹⁷

Among disadvantaged applicants in Wisconsin, 38 percent of those who had received counseling were placed in jobs whereas none of the "not counseled" was placed. For the handicapped, the story was even more dramatic with 69 percent of those counseled being placed compared with none who received no counseling.*

Basic Premises for Guidance Programming

The foregoing section has been presented compelling evidence that guidance and counseling programs can achieve certain social as well as individual goals we share in common with our colleagues in vocational education. This next and final section will fully clarify the foundation for a basic redirection of language in the reauthorization of vocational education. It will do so on the basis that guidance and counseling programs must be central, not peripheral, to the delivery of work-related education and training programs—now and in the future. By presenting five basic premises that form the foundation for need for improvements in vocational education legislation, guidance and counseling programs in our schools and institutions can fully assume their crucial role in responding to national priorities.

First, guidance is a program. As a program, it has characteristics similar to other programs in vocational education, including:

- a. learner outcomes (competencies) in such areas as self

* Editor's Note:

Each of the preceding testimonials to counseling effectiveness were drawn from either of two documents prepared by Nancy M. Pinson: *The Contribution of Guidance and Counseling to the Employability of Youth* (NIE/Ed, September, 1980) and *Legislative Perspectives in Youth Employment, Career Education and Career Guidance* (Pennsylvania State University, July 25, 1980).

knowledge and interpersonal relations, decision making and planning, and knowledge of life roles including worker and learner roles in the form of a guidance curriculum;

- b. activities and processes to assist learners to achieve outcomes such as these;
- c. professionally recognized personnel; and
- d. materials resources.

Second, guidance programs are developmental and comprehensive. They are developmental in that guidance activities must be conducted on a regular and planned basis to assist young people and adults to achieve career development competencies. While immediate and crisis needs of individuals must be met, a major focus of a developmental program is to provide individuals with experiences to help them grow and develop. Guidance programs are comprehensive in that a full range of activities and services are provided including assessment, information, counseling, placement, follow-up, and follow-through.

Third, guidance programs focus on individuals' competencies not just their deficits. To some, a major focus in guidance is on the problems individuals have and the obstacles they may face. This emphasis is important but it should not be dominant. If it is emphasized in isolation, attention often focuses on what is wrong with individuals, not what is right. Obviously, problems and obstacles need to be identified and remediated, but they should not overshadow the existing or potential competencies of individuals. A major emphasis in guidance and counseling programs should be on helping individuals identify the competencies they already have plus assisting them to develop new competencies.

Fourth, guidance programs are built on a team approach. A comprehensive, developmental program of guidance is based on the assumption that all staff have teachers and administrators who see themselves as being involved rather than thinking it is all up to the counselors. At the same time, it should be understood that professionally certified counselors are central to the program as coordinators. In this role, they provide direct services to individuals as well as work in consultative relationships with other members of the guidance team.

Fifth, guidance programs mandate articulation. A basic assumption underlying comprehensive, developmental guidance programming is that there is effective linkage between comprehensive high school guidance programs and

located in area vocational schools and postsecondary institutions. This means that there is program continuity; that those activities begun in the comprehensive high school are carried on, as appropriate, in those area vocational schools and postsecondary institutions. This means that the guidance staffs of these institutions meet together on a regular basis to exchange information and to update their programming as new student needs are identified.

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Experiential Learning and Cooperative Education Programs: A Strategy for Environmental Workforce Development in the 1980's

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The Need for Experiential Learning in Environmental Career Education

If we accept the proposition that the professional and technical environmental workforce of the 1980's ought to be well educated, not merely well trained, then it follows that any sound strategy for the development of this workforce in the 1980's must assign a leading role to higher education. However, environmental workforce planners and policy makers, among others, have historically focused almost exclusively on the formal aspects of higher education, that is learning gained through formalized instructional methods such as classroom lectures, structured laboratory exercises, seminars, workshops and faculty-directed research activities. For example, environmental studies curricula development projects funded by EPA and other government agencies have depended primarily, if not exclusively, upon formalistic learning models of higher education. However,

There are two phases in the educational process: inputting (learning information and techniques), and outputting (synthesis, analysis and decision making). The formalized instructional processes take care of the inputting; experiential learning develops the outputting.¹

In the higher education and training of new professional and technical environmental personnel, experiential learning is not only desirable, but probably essential to the development of

those

complex mental skills that are required to synthesize, combine, transfer and adapt knowledge from one situation to another with skill and sophistication.

What is experiential learning? Perhaps as good a definition as any is found in a 1976 study published by the American Society for Engineering Education. That study defined experiential learning as learning which results from "individualized interaction with situations that are realistic open-ended, complex, unstructured and perhaps even undefined." I believe most environmental professionals would agree that this definition accurately describes many of the work situations in the field of environmental protection, both now and into the 1980's.

There are only two basic categories of experiential learning models: simulation models and authentic involvement models. Simulation models are essentially "contrived situations that are carefully designed to meet selected learning objectives and are under close faculty control." Examples include guided-design seminars, experimental laboratory exercises and computer gaming exercises.

All experiential learning models in the second category, authentic involvement, require that the student be placed in an actual work situation with an employer or client who has a real need for the student's services. Examples include internships, consulting for both on-campus and off-campus clients, and assignments with on-campus clinics or design centers which work under contract, usually to off-campus organizations. However, the most successful and widely adopted authentic involvement-experiential learning model used in higher education today is *cooperative education*. The remainder of this paper examines the concept of cooperative education and its relevance to environmental workforce development in the 1980's.

Cooperative Education: An Overview

The Cooperative Education Association defines cooperative education as

a college program within which students are employed for specific periods of off-campus work as a required part of their academic program. This employment is related as closely as possible to the student's course of study and individual interest.²

The primary purpose of cooperative education is to provide the student with an experiential learning opportunity and to

integrate his experiential learning with his formal academic studies. Usually, the student is awarded college credit for the successful completion of his cooperative education assignment. Ordinary college work/study programs are *not* cooperative education. The former is not an experiential learning program but only a form of student financial aid. Under work/study there is no requirement that a student's job bear any relationship to his academic studies.

The University of Cincinnati established the first cooperative education program in 1906, when it placed 15 engineering and chemistry students with industrial firms in the Cincinnati area. The success of this program stimulated a handful of other institutions, including Northeastern University, Georgia Institute of Technology, Drexel University and Massachusetts Institute of Technology, to establish similar programs between 1906 and 1921. Over the next 50 years the growth of the cooperative education movement was modest, with an average of one new institution a year adopting the program. The movement accelerated in the 1960's, triggered by the efforts of the National Commission for Cooperative Education. Cooperative education spread rapidly in the 1970's due largely to federal funding for the establishment of new programs under Title VII of the Higher Education Act. Between 1966 and 1976 the number of institutions with active cooperative education programs grew from 133 to 696 and the number of participating students increased from 38,000 to 156,000.² Growth, although probably at a slower rate, has continued since 1976 to the present.

In its early years, cooperative education was confined to schools of engineering and technology. In 1921, Antioch College became the first liberal arts institution to establish a cooperative education program.⁴ Today, there is hardly an academic discipline or specialty which does not use cooperative education as a learning model. The 1978 *Directory of Cooperative Education* identified over 125 different academic disciplines by title among the 156,000 co-op students placed in 1976.⁵

Engineering, however, continues to be the discipline with the greatest participation in cooperative education. The 1980 *Engineering Co-op Directory*, published by the Cooperative Education Division of the American Society for Engineering Education, listed 265 colleges and universities, including two year institutions, which operate some type of cooperative education program in one or more of the engineering disciplines.⁶

Cooperative Education and Environmental Workforce Development

In the remainder of this paper the value of cooperative education to the environmental workforce development process of the 1980's is examined from the perspective of each of the three principal participants in this process: (1) the student considering or preparing for an environmental career, (2) the educational institution offering programs in environmental studies and related disciplines, and (3) the environmental employer.

The Student's Perspective:

1. *Career planning.* The student considering a professional or technical career in the field of environmental protection today is confronted with an extremely broad range of career choices. Not only is there a growing number of environmental occupational specialties, but most of the traditional disciplines in engineering and science as well are utilized in environmental protection activities. This diversity of disciplines is demonstrated in the new *Environmental Protection Careers Guidebook* which describes over one hundred separate environmental occupations.⁶ To further complicate matters, there is no one-to-one correspondence between a graduate's academic credentials and his entry-level job, much less his long-term career path.

Unfortunately, too many students formulate their goals in an experience vacuum. Career guidebooks, counseling and academic study, even in combination, often do not provide an adequate basis for a student to formulate suitable career goals. One of the major benefits of cooperative education is that

Most of the jobs performed by cooperative students afford them opportunity to observe a range of vocations and professions actually being performed. Consequently, students can measure themselves against the requirements of the jobs they are in and those that they observe closely. They also gain a more realistic understanding of the tasks involved, the conditions under which they operate, and the kinds of rewards obtained in a variety of occupations. Furthermore, in large organizations the planned work experience provides for movement upward into jobs that require increasing skills, knowledge and responsibility. Through these experiences, students

can either confirm their earlier choice of careers or realize before too long that they have made an unwise choice. If they have made a wrong choice, they can replan their careers and the educational programs appropriate to them.'

2. *Evaluating relevance of academic studies.* A student's motivation to study, and thus usually his academic performance, depend heavily upon his perception of the relevance of his academic studies to his environmental career goals. Cooperative education students are usually better able than non-co-op students to independently evaluate the career relevance of their academic studies. Those students in relevant programs can find meaning through cooperative education

because the theories and principles learned in the classroom are reinforced and given concrete application on work assignments and because they increasingly perceive, as their experience continues, the relevance of what they are studying to the situations they encounter while off campus on the job.'

Those students who, on the other hand, are unfortunate enough to be in academic programs irrelevant to their environmental career goals can, through their co-op education work experience, often discover this mistake and replan their academic program before it is too late.

3. *Financing academic studies.* College students generally are being squeezed between rising educational costs and reduced financial aid available under federal and state programs. Students preparing for careers in environmental science and engineering have especially been burdened financially as a result of the termination of the EPA academic training grant and fellowship program, as well as related programs of the National Institutes of Health and the National Science Foundation.

Cooperative education often is an important, if not the primary, means by which students can finance their formal education. The great majority of cooperative education agreements require that the student be paid a wage or salary rate comparable to that paid to other entry level permanent employees performing the same kind of work. Wage and salary rates for co-op students, like other workers, vary widely depending upon such factors as the job requirements, the student's educational level, and the type, size, industry and location of the employer. A recent major study found evidence that employers tend to pay co-op students, as compared with permanent employees,

somewhat lower wage and salary rates. This study, nevertheless, concluded that "cooperative education is an effective financial aid device for students of all types."⁷

4. *Finding permanent employment upon graduation.* The environmental job market in the 1980's will likely be highly competitive for a number of reasons, even in the specialized professional and technical occupations. First, both public and private sector expenditures for pollution control will either level off or decline somewhat. Second, the attrition rate for the existing workforce will probably decrease as workers postpone retirement or experience less mobility in transferring to other fields. Consequently students planning environmental careers in the 1980's have no assurance of securing good jobs in their field upon graduation, regardless of their academic credentials.

Graduates of cooperative education programs in general have a definite advantage over non-co-op graduates in finding permanent jobs, according to several recent studies on this subject. One major indepth study of nine large co-op employers, for example, found that graduates of co-op programs were almost *nine* times as likely to be offered permanent jobs as non-co-op graduates applying for the same types of jobs. This same study also found that in a group of 60 other employers, 77 percent rated their experiences in recruiting co-op graduates as excellent or good, compared to non-co-op graduates.⁸ In another study it was found that 73 percent of a sample of 33 co-op employers reported that they had a policy of hiring co-op students as fulltime employees when positions became available.⁹

The Educational Institution's Perspective:

1. *Financing environmental studies programs.* The 1980's is likely to be a lean period financially for higher education in general and environmental studies programs in particular. The termination of EPA's academic training grant and fellowship program has already been noted.

Proposed cuts in Basic Educational Opportunity Grants, Guaranteed Student Loans, College Work-Study, and other student financial assistance programs administered by the U.S. Department of Education would likely further depress enrollment levels generally. It is probable, moreover, that many other federal programs of direct financial assistance to colleges and universities will be cut back if not eliminated entirely. Consequently,

unless state funding is increased proportionately, colleges and universities will find it necessary to fund their academic programs, including environmental studies programs, through increases in student tuition.

As noted above, cooperative education has been demonstrated to be an important financial aid device to students generally. Environmental studies programs dependent upon tuition revenue for their continued operation in the 1980's, would do well, therefore, to establish and promote cooperative education programs for their students.

2. *Student recruitment.* Environmental studies programs in the 1980's will probably survive only if they can recruit tuition paying students in sufficient numbers to cover most program costs. In addition to the numbers problem, there is also the problem of student quality for those programs concerned with maintaining a reputation for producing high quality graduates.

One of the widely acknowledged benefits of cooperative education to the participating schools is the "easier recruitment and retention of qualified students."¹⁰ Such students are usually quick to recognize the direct benefits of their participation in cooperative education.

3. *External relations with environmental organizations.* With the exception of research, academicians as a group tend to operate on the periphery of major developments in the field of environmental protection. It is essential, therefore, that environmental studies programs resist academic isolationism if their curricula are to stay current with the state-of-the-art and thereby meet the needs of students for relevant career education.

Cooperative education breaks down academic isolationism in two ways. First, in most cooperative education programs some of the teaching faculty usually function as advisors and coordinators for the co-op students. In this capacity, faculty often work directly with co-op employers in designing their students' work assignments and in evaluating their performance. These advisors/coordinators often conduct on-site visits at the co-op student's place of employment. These contacts with the co-op employer occasionally evolve into broader long-term working relationships. Second,

students bring back to the campus, the classroom, and the faculty up-to-date information on industrial and business practices and new technology. This feedback helps to keep the curriculum current and relevant.'

4. *Instructional equipment and facilities.* In many environmental protection specialties, for example water pollution control engineering, students should become familiar with, if not proficient in the use of, a variety of highly sophisticated and expensive equipment and facilities. However, many environmental studies programs in science, engineering and technology do not have the necessary economies-of-scale to purchase, operate and maintain such equipment and facilities; they have to make do with on-campus equipment and facilities which are obsolete.

When one considers the wide range of pollution control hardware either in use or under development today, the economic advantages to educational institutions of using off-campus facilities becomes evident. Cooperative education provides students with the opportunity to become familiar with and proficient in the use of their employer's equipment and facilities, which are often the most advanced and sophisticated. This can lighten the financial burden on educational institutions who place the students.

5. *Job placement of graduates.* Educational institutions have an obligation to assist their graduates in finding permanent employment upon graduation. In recognition of this obligation, many institutions operate elaborate and expensive job placement services.

Cooperative education can greatly simplify and reduce the cost of job placement of the institution. As shown earlier, a graduate of a cooperative education program stands a very good chance of being offered a permanent job by his co-op employer. In addition, recent studies have found that co-op employers who have had favorable experience in hiring co-op students and co-op graduates frequently make special efforts to recruit non-co-op graduates from the same educational institutions.^{7,11}

Considering both of these factors, institutions probably realize a net savings in job placement program costs through the operation of a cooperative education program.

The Employer's Perspective:

1. *Controlling recruitment and hiring costs.* The environmental employer is just as interested as any other type of employer in controlling his recruitment and staffing costs. However, he is often competing with other employers for

a limited supply of new college graduates, especially in certain environmental science and engineering specialties. In order to meet this competition, he may incur great expense in visiting college campuses, meeting with faculty and interviewing graduating students.

One of the major benefits of cooperative education to the employer is that it can greatly reduce his recruitment and hiring costs. One study, for example, found that the average recruiting yield (the ratio of the number of job acceptances to the number of candidates interviewed) was approximately *thirteen times* as high for co-op graduates as for non-co-op graduates. This study also found that, for the group of employers as a whole, the median average recruitment costs per new hire were *sixteen times* as high for non-co-op graduates as for co-op graduates. This study concluded that

cooperative education clearly is an efficient and cost-effective approach to the recruitment of professional and preprofessional employees.⁸

2. *Recruiting productive employees.* The environmental employer is just as interested in good employee performance and high productivity as any other type of employer. There is a considerable amount of evidence that graduates of cooperative education programs demonstrate superior job performance as compared with non-co-op graduates in the same type of jobs. In one major study, for example, which compared the job performance of co-op graduates to non-co-op graduates, the actual performance evaluations of 738 employees were analyzed for three twelve-month work periods. The study found that "co-op graduates received a higher evaluation of work performance in each of the three work periods."¹²

Other studies have found evidence that the job performance of co-op *students* as well as co-op graduates is superior to that of non-co-op permanent employees doing the same type of jobs. One study involved thirty-four employers who participated in the co-op program of a large community college in New York City. It was found that both co-op program graduates in permanent, entry level positions and co-op interns in temporary positions were given significantly higher job performance ratings than those given to non-co-op graduates in entry-level, permanent positions. Interestingly, the study also found that another group, non-co-op employees in training level positions, ranked above non-co-op permanent employees,

but below both co-op graduates and co-op students. Employers were also asked to respond to the statement that "graduates of cooperative education programs are more skilled in their career (work) area than non-cooperative college graduates." Of those responding, over three times as many agreed as disagreed with this statement.⁹

In another major study, 250 employers were asked to evaluate the job performance ratings of co-op student workers compared with that of regular, non-co-op permanent employees. The performance ratings were made on the basis of eight performance criteria: technical knowledge, communications skills, quality of work, quantity of work, cooperation with fellow workers, dependability, ability to follow instructions and motivation. The study found that

for all eight of the skill categories, the overwhelming majority of the employers reported that co-op students perform as well or better than regular employees.⁷

3. *Relations with the academic community.* The need for strengthening and broadening cooperative working relationships among educational institutions, industry and government on environmental problems and programs likely will grow in the 1980's. In the past few years there appears to have been increased interest on the part of both government and private industry in securing greater involvement by the scientific academic community in developing new pollution control technologies. The National Academy of Sciences' 1977 report, *Manpower for Environmental Pollution Control*, urged that "cooperation between educational institutions and pollution control organizations should extend beyond cooperative education arrangements for students."¹³

One recent study on the employer benefits of cooperative education concluded that "most employers who participate in co-op believe that the co-op program is a step toward schools responding to their needs."⁷

Another study concludes that:

A mutual industry-university relationship is enhanced through the cooperative education program. In some cases the strong relationship has paved the way for other joint projects of mutual interest.¹¹

SUMMARY/CONCLUSIONS

The environmental problems of the 1980s demand a professional and technical environmental workforce which is well

educated, not merely well trained. Higher education, therefore, must play a central role in any comprehensive environmental workforce development strategy. Experiential learning is an essential phase in the process of educating students for environmental careers. Cooperative education is the best established, most widely adopted form of experiential learning in higher education today. Viewed alternatively from the perspective of the student, the educational institution and the employer, cooperative education clearly has significant value as a strategy for environmental workforce development in the 1980s.

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Apprenticeship Program for Environmental Occupations

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INTRODUCTION

In this brief paper, I would like to take you through a process that thousands of potential apprenticeship program sponsors have followed for over 40 years. Let's take a look at the city of Wonderland which has made a management decision through their city council to upgrade the skills of employees in what the city calls their public works department.

The city has decided that many of their key craft employees in the public works department are fast reaching retirement age and some process must be started to pass on the skill, technical know-how and knowledge of these key employees to those who will replace them.

Wonderland is a progressive city and has had successful apprenticeship programs for over three years in the police and fire department. The manager of the public works department sits down with the fire chief and the police chief and explains his predicament. He ends his presentation with this simple question—"What should I do?" Both chiefs answer unanimously—"Call in the BAT man!"

A meeting is set up with the BAT representative and the manager of public works department. The manager of the public works department makes his presentation to the BAT representative and then asks the question: "I don't know if I have apprenticeable occupations in the public works department." The BAT man explains that the National Apprenticeship Act of 1937, commonly referred to as the Fitzgerald

Act, which established BAT, has day-to-day operating criteria cited in the code of federal regulations, title 29 part 29, that sets standards for apprenticeable occupations.

Determining Apprenticeability

Part 29.4 of the regulation, titled "criteria for apprenticeable occupations," states that an apprenticeable occupation is a skilled trade which possesses all of the following characteristics:

- A. It is customarily learned in a practical way through a structured, systematic program of on-the-job supervised training.
- B. It is clearly identified and commonly recognized throughout an industry.
- C. It involves manual, mechanical or technical skills and knowledge which require a minimum of 2,000 hours of on-the-job work experience to learn.
- D. It requires related instruction to supplement the on-the-job training.

Once a skilled trade meets the four requirements listed above, the bureau also uses the dictionary of occupational titles (DOT) for additional backup information. We use the DOT's specific vocational preparation (SVP) code as an indicator to determine if, in fact, a skilled trade requires 2,000 hours of on-the-job work experience. In addition, we will determine from the DOT the reasoning, mathematical and language development (RML) for a given skilled trade. Our last tool in examining the skilled trade is the skill level occupation code, which of course, is an indicator for the skill level of a given occupation.

As you may have guessed we rely heavily on the findings of occupational analysts in determining what occupations are apprenticeable.

Careers Handbook

Now that you have an understanding of how we determine apprenticeability, let us take a look at the occupations listed in the environmental protection careers guidebook. There are 102 job titles listed in the index and these occupations cover anywhere from a half-page up to two pages of descriptive information. The information for each job title is a description of the job, the job requirements and job opportunities, with the DOT code as my key code. The job titles run from microbiologist (professional) through water-treatment-plant

operator (skilled) to industrial waste sampler (semi-skilled). A total of 89 occupations were eliminated because they were either professional (requiring a B.A. degree or higher), or semi-skilled (requiring less than 2,000 hours of on-the-job work experience).

The 20 apprenticeable occupations by industry-wide categories are:

Water treatment occupations:

Meter Repairer - 710.281-034	2 years
Pump Station Operator - 954.382-010	2 years
Water-Treatment-Plant Operator - 954.382-014	2 years

Waste water treatment occupations:

Industrial Waste Inspector - 168.267-054	2 years
Treatment Plant Mechanic - 630.281-038	2 years
Wastewater-Treatment-Plant Operator 955.362-010	2 years

Irrigation occupations:

Watershed Tender - 954.382-018	1 year
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Research, Development and Design occupations:

Drafter, water and sewer - 005.281-010	4 years
Hydrographer - 025.264-010	2 years

Noise Control

Audiometerist - 078.362-010	2 years
Noise Technician-029.261014	2 years

Air Resource Management

None

Land, Fish and Wild Life Management:

Conservation Officer - 379.167-010	4 years
Park Ranger - 169.167-042	4 years

Pesticides and Toxic Substances:

Entomology Field Assistant - 049.384-010	2 years
Pest Exterminator - 389.684-010	1 year

Solid Waste Management:

None

Radiation Control:

Radiation Monitor - 199.167-010	2 years
Radiological Instrument Technician 710.281-026	4 years

Other Environmental Activities:

Chemical Laboratory Technician - 022.261-010	3 years
Engineering Aide - 017.281-018	2 years
Engineering Aide - 869.567-010	2 years
Laboratory Aide - 381.687-020	2 years

In addition to these 20 occupations, the environmental protection careers guidebook lists seven other occupations that appear apprenticeable but at the time the guidebook was published they had not been assigned DOT codes and thus no apprenticeability determinations could be made at the time. We still do not have DOT codes for them. They are: photo inspection technician, T.V. technician, pest control helper, vector control assistant, sanitation inspector, chemical radiation technician, and radiation laboratory technician.

"Clearing the Decks"

The works' manager then selects those occupations that are apprenticeable in his operation and determines that, of the 19 occupations, 12 are apprenticeable. Working with the city's personnel experts, the public works department works up apprenticeship standards for all 12 occupations. The BAT man provides expertise. These 12 occupations cover about 45 jobs in the department.

The next step is to determine who among the 45 job holders will be retiring and when. Once that factor has been established, a timetable is created to dovetail expected retirements with the actual hiring of apprentices. It would be illogical to start an apprentice program in all the occupations at once.

Another consideration would be what has been the experience of the department in skilled workers who leave the job and the death rate. Both of these elements should be taken into consideration in terms of apprentice numbers.

A conference with the people in the city government involved with budget is a very important step also. An apprenticeship program, on the face of it, may sound expensive to budget conscious city officials. The manager and the BAT man should work up a sample schedule of two year apprenticeships, pegging the dollar amounts for the first six months, the second six months, and so forth, to give a good idea of what the concept may cost. It is always intelligently prudent to be forthright in such matters. If the concept of apprenticeship is bought, the program should not become a matter of budgetary surprises from year to year—a certain way of killing a good program. Apprenticeship, in the case of the city of Wonderland, should be sold as the cheapest form of insurance in maintaining good, uninterrupted vital services to the community.

The decks cleared for action, it may be found that three current jobholders will be retiring in about two years time. The

city of Wonderland's public works department advertises apprenticeships openings for three apprentices for the occupations involved. The apprenticeship standards established for these occupations determine the basic qualifications required by the applicants.

Finalizing Process

The final step is the testing of the applicants by the city's personnel department and the selection of the workers, all according to another title in the code of federal regulations, this one, title 29, part 30, dealing with the selection of apprentices without discrimination.

Four persons, three men and a woman, are hired as apprentices, and the vaunted old system is once again demonstrating the best method ever devised by man in the transmission of skills from skilled worker—the teacher—to the novice worker—the learner.

The citizens of Wonderland are sleeping well these days—secure in the knowledge that their public works department will continue to function efficiently.

Environmental Workforce Needs— Union Programs

**Reese Hammond
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As a representative of the trade union movement in the United States, I appreciate and welcome the opportunity to contribute to this publication. As a member of, and one-time worker in, the Operating Engineers union, I have specific job related concerns regarding:

1. Noise pollution;
2. Water treatment;
3. Waste water treatment;
4. Hazardous waste disposal;
5. Radioactive materials and their waste disposal, and
6. Clean air.

In my own union, we have been concerned about the dangers to our environment since long before there was an EPA.

1. 1959-63, in conjunction with the Stanford Research Institute and the Oak Ridge National Laboratories, we ran a series of successful courses on the industrial use of radio isotopes.
2. Since 1961, we have rejected the idea that deafness was a normal incidence of heavy equipment operation. Ultimately, we did work with Mary Ellis Associates to develop, under EPA's auspices, an eight hour course for our members on "Understanding Noise and Noise Control."

Despite these modest, but important activities regarding our work place environment, I reviewed the Environmental Protection Careers Guidebook, which has been discussed here and found out that contributors included:

1. 7 federal agencies
2. 81 state agencies
3. 18 local government departments
4. 17 industry and business sources
5. 24 educational sources
6. 9 membership groups

but . . .

not one single union source.

Our union represents thousands of workers in the titles listed in the Environmental Protection Careers Guidebook.

1. Almost all of the water treatment and waste water treatment titles appear in dozens of our contracts.
2. We have registered apprenticeship programs for stationary engineers, treatment plant operators, bio medical technicians and several other skilled and technical positions.

All this is simply to say we are involved in problems of environmental protection, both in jobs identified as full-time environmental protection jobs and in the rest of our jobs to the extent that we are exposed to environmental hazards as we do our work.

If my remarks sound a little provincial, it's because a union's primary job is to protect its members from economic and physical harm, and to equip them with the skills to assure economic security and safe working conditions.

In the craft unions, and to an increasing extent, in the industrial unions, the highly skilled jobs are generally learned through apprenticeship.

1. An apprentice, unlike his contemporary who is a college student, earns pretty good money as he obtains the knowledge and skills of his/her trade.
2. A four year apprentice in my trade will have his journeyman's ticket at the end of his education and training, will have earned about \$33,000 and will be making \$12-\$15 per hour.
3. A college student, going through the same four years at a state college will have spent \$33,000 and will start work at \$9-\$10/hour.
4. So one of the characteristics entering a career in the craft unions is that, at least in the short run, you wind up \$66,000 ahead, and are equipped for a good paying job.

Some of the good paying jobs will be as part of the environmental work force, and because a construction worker, by definition works himself out of a job, those of our members

who are construction hands may enter and leave the environmental work force many times.

It seems to me that it's important to address the construction work force and the environmental work force because the mammoth "clean up" that this country needs will require millions of construction man hours,

- a. treatment plants
- b. recycling plants
- c. hazardous waste removal

to name only a few

Secondly, I believe it's obvious to any economist that in the initial stages of the development of a new work force, most of the workers will come through inter-industry transfers.

- a. The construction worker, because of the broad training he has received, is ideally suited for "career changes" into related fields.
- b. There is in fact a steady outflow of construction workers to other industries—we do a lot of training for other industries—including the rapidly emerging environmental protection industry.

There are a lot of other jobs for which we train people. I've mentioned several of the "mainstream" environmental occupations, i.e. stationary engineer and treatment plant operator.

These are fairly traditional occupations and I don't want to spend unnecessary time discussing them. I do want to point out that our curricula in these fields are under constant review, and the changes resulting from technological advances are incorporated into our training programs. Today's graduate is prepared for tomorrow's job.

Less well-known as environmental work force occupations are such jobs as surface miner and well driller.

- a. While such occupations may, at first blush, appear to be the antithesis to the environmental work force, sober consideration has to acknowledge that energy extraction must continue—but it must be done in an environmentally sound way.
- b. The Western Conference of Operating Engineers, composed of our local unions in the 13 western states, has established the Surface Mining Institute, with campuses in six western states.
- c. all of the skills needed in the operation of open mining will be taught, and will be taught in an environmentally sound way.
- d. we hope, as the institute matures, to enter into cooperative efforts with other educational institutions

with input into the surface mining industry to further refine extraction techniques and recontouring schemes.

Our International Union is, under contract with the U.S. Department of Labor, developing a performance based apprenticeship program for oil, gas and geothermal drilling.

- a. The environmental problems incident to this kind of work are pretty well identified, and more may arise.
- b. The most important concerns in the environmental area are that our apprentices are alerted from the beginning of their training to the proper procedures for use of chemicals, protective devices and correct methods for eliminating any permanent environmental damage.

This is an abbreviated profile of some of the training programs sponsored by the International Union of Operating Engineers. They impact the environment, and they are impacted by the environment.

- A. There are over 300 apprenticeable trades registered with the U.S. Department of Labor, but of the 400,000 registered apprentices, 60% are in the 25 programs registered by building trades unions.
- B. Other union spokesmen could have done this little presentation as well, if not better than I, but on behalf of the trade unions with apprenticeship programs, I want to thank you for the opportunity to address you.

I want to close with one last comment. Our union is dedicated to creating an *educational* environment where options are left open for individuals.

- A. There should be no arbitrary barriers to an individual's economic or social progress through life. Ability and ambition should be the determining factors.
- B. We have tried to create an education and training system which encourages individuals to become all they can become.
- C. Through our dual enrollment program, more than half of our 7,100 indentured apprentices are banking junior college credits as they go through apprenticeship.
- D. We have arrangements with an increasing number of senior colleges to recognize the junior level academic credits from dual enrollment in four year, degree programs at the baccalaureate level.
- E. Lastly, separate and apart from our formal training programs alone, or with academe, each year thousands of journeymen take skill improvement courses to keep their skills current.

If, in fact, education is power, we have no intention of ceding

the field to entrenched interests of any kind—we will share the power, but we won't give it up.

The environmental work force will be expanding in the foreseeable future and as our members skills match the available jobs, we'll see that our members are prepared to do those jobs well.

Education and User Acceptance of New NASA Technologies

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INTRODUCTION

The first Landsat earth resources satellite was launched in 1972, less than 10 years ago. Viewing most spots on earth in four bands of the spectrum with 80 meter resolution on an 18 day repeat cycle, Landsat data has been used with varying but substantial success, e.g., to map current status and changes in land cover for non-point source pollution assessments, coastal zone and wetland resources, surface mines, severe insect infestations, urban expansion and a variety of other environmentally significant issues. Although basic capabilities have been demonstrated and are being expanded in research programs, acceptance of the technology has been slowed by the unfamiliarity of potential users with the capabilities (and limitations) of satellite data and the techniques for using it.

NASA's Technology Transfer programs serve as an adjunct to its R&D program in adapting and transferring established techniques to operational use.

Technology Transfer Program

The objective of NASA's Technology Transfer program is to ensure that the public and private sectors derive maximum possible benefits from the technology that NASA develops, maximizing the return on Federal investment in the technology development. The program includes space applications activities to promote and develop capabilities to use remotely sensed data for resource and environmental management by Federal agencies, state and local governments, and private industry.

The program provides an outlet for discipline technology development programs by encouraging the broad scale, direct dissemination of proven technology to potential users and by stimulating the private and university sectors to provide services to emerging users. In addition, because of extensive interfaces with a wide variety of users, the program serves as a two-way information channel through which user requirements can be gathered, synthesized and focused for planning of new technology programs and, users can be informed of available technology.

Program Strategy

The Technology Transfer program operates in a dynamic environment characterized by changing national economic, technical, and societal goals and priorities. The success of any program strategy depends on maintaining awareness of users' needs and providing solutions to meet those needs. The specific elements of the technology transfer program strategy are as follows:

1. Systematic identification of user needs and priorities and of NASA technologies that are potentially applicable to satisfying those needs.
2. Development of new technology transfer opportunities through liaison with industrial associations, and cooperative activities with user representative groups such as the National Governors Association and National Conference of State Legislatures.
3. Demonstration and verification of technologies in the users' environments by means of in-depth systems demonstrations to determine technical and institutional requirements for operational uses of new technologies as well as their resulting benefits.
4. Adaptation and diffusion of technologies to the user community through training, individual user demonstrations and technical assistance.
5. Dissemination of the results of NASA's technology activities to the private and public sectors through user oriented publications, symposia, and other media through NASA and non-NASA communication networks.
6. Stimulation of the university community through grants sponsoring research, education, and public service activities to build supporting capabilities that could aid NASA's technology transfer programs.

The program strategy translates into four basic program elements: 1) University Applications Program; 2) User Requirements & Awareness Program; 3) Applications Systems Verification & Transfer (ASVT) Program; and 4) Regional Remote sensing Applications Program. Each of the programs and their educational and training activities will be discussed herein.

University Applications Program

To provide a continuing basis to support the use of Landsat and other space applications technology, NASA has worked with the academic sector to develop and strengthen related curricula and basic research through the University Applications Program. To provide future resource managers and researchers with the skills to develop and apply Landsat and future satellite technology, remote sensing centers have now been established at universities in 25 states.

The universities work with state and local governments in applying this technology to current operational problems with demonstrated benefits to the taxpayer. A survey of this program conducted in 1978 showed that they had indeed demonstrated the value of the technology and that many of these universities are becoming self-sustaining and are being supported by outside user funds. Several of these universities now have remote sensing programs which receive funding of over a million dollars from outside sources.

In order to distribute these benefits nationwide while maintaining a constant level of total program funding, each year one or two programs are phased out as new programs are initiated at universities in other states. A process instituted in FY79 for the selection of the new additions considered recommendations from the three NASA Regional Centers that would further enhance cooperative activities at the state level.

In addition to approximately 3000 students annually enrolled in interdisciplinary remote sensing courses, these centers annually provide support for training and experience in remote sensing research and applications to about 400 graduate students each year. About 200 faculty are involved in the research each year.

As a result of its success in remote sensing applications, the University Applications Program is now increasing the involvement of the academic community in basic research in a variety of applications disciplines. In addition to our on-going basic research programs in geodynamics and materials processing, we have initiated a basic research program this year in geology. The geology program will examine ways in which improved

rock-type discrimination can aid mineral assessment and exploration.

Three grants, especially in remote sensing, develop a university capability for research, education and public service. Research opportunities certainly attract graduate students and faculty members since it offers research topics for master's and doctor's thesis and possibilities for some support.

As the capability is developed and institutionalized a body of knowledge and expertise is available from which new curriculum/courses are developed or modules developed for insertion into the standard discipline courses. Equally important from the teaching perspective is the proper equipment and facilities for technology demonstrations and experimentation which have been established on campus.

By working with state and local agencies, personnel get acquainted with the technology and the equipment. After personal, hands-on experience they are able to judge the suitability of the technology for their operational problems. The university becomes an in-state center of expertise and an operational laboratory for solving real work problems. It is also a center for training through short courses or special programs tailored to agency needs.

User Requirements and Awareness Program

The User Requirements and Awareness Program is responsible for maintaining continuing communications between NASA Applications and the user community to determine user needs, inform users of existing and planned technological capabilities, and to provide user feedback as an input to NASA program planning. The program also develops analyses and studies such as market evaluations, technology surveys and socio-economic benefit analyses which are required to support, facilitate and evaluate the technology transfer process. Studies are conducted to identify and analyze Federal, state and local government and private sector user requirements in order to establish a user needs driven, pro-active approach for technology transfer activities.

The program develops formal institutional relationships and two-way communications with organizations such as the National Conference of State Legislatures (NCSL), the National Governors Association (NGA) and the Intergovernmental Science Engineering and Technology Advisory Panel (ISETAP) to ensure that potential user communities are aware of existing and/or planned technologies; and to facilitate the transfer of

technology by the creation of an informed receptive user community. As part of those cooperative activities, NCSL has published brochures entitled, "A Legislator's Guide to Natural Resource Information Systems" and "State Institutional and Technical Approaches to Landsat Utilization," to increase national awareness of how Landsat data can be and is being used for natural resources management. Similar brochures have been provided by NGA for use by managers of state natural resources. It is important to note that the transfer of new technology involves the education of policy makers/managers as well as the technical personnel who implement the technology. Documentation is developed for both policy and technical personnel.

The program uses change agents such as professional societies, e.g., American Society of Photogrammetry, industry associations/trade unions, community colleges and non-profit institutes to more effectively orchestrate the transfer of new technology within the existing institutional, fiscal and technical infrastructure of the user communities and to generate a multiplier effect in the NASA transfer activities. A good example of this is the transfer of technology to the community through the community colleges. Recent surveys show that a large number of locally based private companies and local government agencies are interested in becoming consumers or suppliers of Landsat-derived products and services. However, they have been prevented from entering this market by the high cost of data analysis facilities and the difficulty of obtaining training in the new technology. To evaluate methods for bridging this gap, NASA established a program with the Environmental Research Institute of Michigan (ERIM) in 1979 to investigate methods of making Landsat technology readily available to a broader set of private sector firms through systems of local community colleges. Most of the local users and private sector firms will use this technology for environmental impact assessments, land use planning, facilities siting, and community services planning including transportation planning and power demand projections.

To achieve the desired objective—the successful transfer of Landsat technology—the program utilizes a network consisting of NASA, university research institutes, community colleges, and local private and public organizations. The methodology employed by the program gives local users an opportunity to obtain "hands-on" training in Landsat data analysis techniques, using a desk-top, interactive "Remote Analysis Station" (RAS). The RAS communicates with a central computing facility via

telephone line, and provides for generation of land cover maps and data products via remote command.

This effort has demonstrated that recent development in computer technology now make it possible for the private sector to provide high-quality Landsat products and services, using a desk-top computer terminal, at low initial investment of about \$20K. It also shows that community colleges and private and public organizations readily available to the local user community can join in cooperative efforts to deliver the needed training in the use of the terminals and the application of Landsat technology. In addition, this approach permits a gradual expansion of the initial low-cost user facility as confidence and available capital increase and as the system shows potential for easily merging other sources of data (soil, topography, etc.) into the Landsat analysis process.

The User Requirements and Awareness Program maintains on-going user communications activities consisting of the conduct of symposia, workshops and technical conferences; and the publication and dissemination of user assistance manuals, newsletters, brochures, project report, and procedural manuals to users of NASA Applications technology.

In part, technology adoption by a wider community of users may be hampered by a lack of widely available awareness information and documentation of operational procedures and techniques for applying remotely sensed data. Ultimately, technology transfer requires extensive interfacing of people. Documentation can hardly do the job alone, but proper documentation in user oriented formats provides tools for reaching a larger user community, improving understanding of the technology capability and requirements for adoption, thus speeding the transfer process and improving success ratios. Such handbooks have been developed, i.e., Landsat Users Assistance Manual with application supplements, and the Legislative Outreach Series. The series is a set of communication brochures that identifies the contributions of Landsat technology to meet data needs of Federal grant programs to states for planning and management of natural resources.

Plans for additional applications supplements to the newly developed Landsat Users Manual handbook are being considered to establish "benchmarks" in proven technology areas and provide guides to the capabilities and limitations of present technology. Equipment and software survey publications are already being produced and made available to state governments and will continue. Procedures are established for directly

translating the results of NASA's R&D into Regional Center training and demonstration capabilities to make best use of established user contacts and NASA transfer capabilities and investments. Periodic user conferences like those initiated through the Regional Remote Sensing Applications Program will continue as a means of stimulating inter-user communications in operational uses of space technology with possible extension to other user communities.

Applications Systems Verification and Transfer (ASVT) Program

The responsibility of the ASVT program is to demonstrate, verify and transfer total application systems to users in representative operational settings with the direct participation of the user organizations. ASVT's emphasize adaptive engineering, development of compatibility with users' existing systems, cost reduction and refinement of the total system. The products of an ASVT are verified processes or methods for using applications technologies to solve operational problems such as those related to monitoring the earth resources, managing water resources and maintaining the quality of the environment. An integral part of the ASVT is the training and education of the user. This training process is very similar to that described in the Regional Application Program.

Regional Remote Sensing Application Program

States and local governments under Federal regulation, bear major responsibility for implementing the mandates of resource management and environmental legislation of this past decade. Since 1976, NASA's Regional Remote Sensing Application Program has been directed at making Landsat technology available to those users through liaison, training, technology demonstration and technical assistance. The goal of these activities is to provide users with a first-hand basis for deciding if Landsat technology meets their needs and, when desired, to provide users technical assistance in acquiring necessary capabilities. The program is administered through three NASA field installations which function as Regional Centers covering all 50 states.

Education and training are viewed as critical to meeting both immediate and long term needs so the specific objectives of training efforts have been twofold, namely (1) to prepare state/local government technical personnel for direct participation in the technology demonstration projects; and (2) to build a

self-sustaining base for continued training of additional resource managers in the state.

Basic training for state resource managers assumes participants have only discipline expertise and/or computer systems experience—but not necessarily any familiarity with remote sensing. Training, in groups of 6 to 12 requires 1 to 2 weeks, depending on the experience of the participants. Since 1976, detailed training in data analysis has been provided to over 1500 personnel in 35 states, including nearly a thousand state government officials. Courses are relatively standardized at the three Regional Centers (and documented for two of them) but modularized to accommodate individual class needs and state interests. Special topic courses for repeat groups have grown in importance and will continue to deal mainly with advanced data processing techniques, special software or new technology long after NASA has phased out of basic training. The groups trained in these courses are selected and sized to represent an adequate core for establishment of a state-wide program. Training, in fact, has not been the major problem in establishing state capabilities. Rather system acquisition delays, personnel transfers and institutional re-organizations have proven the biggest impediment to implementation.

Building a self-sustaining base for future training of other resource/environmental managers has generally involved universities within the states. In some states (e.g., South Carolina, Louisiana, Vermont, Oregon) university involvement is a natural consequence of their designation as host of the state Landsat data processing system. In other states a variety of mechanisms has been used to build capabilities including short courses, summer faculty programs and area-wide university coordinating councils.

University short courses have been used in the Southern Region to establish university programs for training state and local personnel in the operational use of remote sensing as well as to develop updated expertise in remote sensing among the faculty. Initially, these short courses were designed as faculty training courses directed at broadening the base of familiarity with remote sensing, from experts in one or two departments (e.g., land use planning and forestry) at a given university, to the full range of resource disciplines required for state programs. In the past year, these programs have been increasingly directed to conducting training for state agency personnel, i.e., pilot classes for what should become a continuing university function. To date short courses in 8 states have trained some 265 university faculty in the application of remote sensing. University faculty

have also participated in the regular training courses bringing the totals to over 500 faculty members from 14 states. Except for updating users with new technology as it becomes available, NASA training interaction with these states will be reduced as the training function is taken over by the universities.

In the Eastern Region, summer residence programs sponsored in cooperation with the American Society of Engineering Education (ASEE) have provided 18 university professors from 8 states with an opportunity to spend a summer at the Goddard Space Flight Center to receive instruction in remote sensing and to develop their own remote sensing application projects with the assistance of NASA personnel. With practical experience in problems largely directed at environmental and resource issues in their own states, these faculty members have returned to their own states stimulated and prepared to serve as a nucleus of capability for the development of state programs. Development of a self-instruction course in remote sensing (planned for publication this year) has grown in large part from the exercises developed for this program. This course consists of a 500 page instruction manual with over 300 illustrations, practice exercises and simulations. The self-instruction course promises to be a major tool for increasing familiarity with remote sensing in the eastern/north central U.S., for which it was designed.

Major support of remote sensing capability development with universities in the Western U.S. dates from the early days of Landsat. An attempt to knit together existing capabilities and support emerging interests was the rationale for formation of a regional Remote Sensing Science Council. The Council is comprised of one university representative from each of the 14 states served by the NASA Western Regional Applications Program (WRAP). The Council's activities have focused on surveying current university involvement in remote sensing such as staff, courses and equipment, providing a forum for the exchange of educational materials on remote sensing, conducting regional training seminars to utilize existing expertise in the region to bootstrap new programs and defining training requirements (overall and specific, e.g., topical modules) for both universities and for operational users (e.g., state natural resource and environmental management officials).

Finally, we have used conferences as a mechanism to bring together practicing professionals and educators in the field of remote sensing both to discuss evaluations and uses of the technology in practice and specifically to discuss training/education programs and future needs.

In the first area--current uses of the technology--a series of three Regional Conferences involving all 50 states was held in the fall of 1978 to review progress in state use of remote sensing for operational programs and to build communication links between users. Although the focus of these conferences was on state agency evaluations and uses of Landsat technology, the key to meeting future educational needs was participation from the academic sector. University educators were well represented in these meetings, particularly from states where responsibility for maintaining state expertise in the use of Landsat data is assigned to the university. In such situations the prospects for meeting education and training needs are very good because of the natural interactions between resident expertise and curriculum development.

A second series of user conferences on current use of the technology is being held this spring--March 9-12 in Danvers, Massachusetts, March 30--April 1 in Seaside, California and June 29-July 1 in Biloxi, Mississippi.

Training and educational needs were more directly addressed in a 1978 Conference of Remote Sensing Educators held at Stanford University. The real key to future operational use of remote sensing is proper training of the resource managers now being graduated from universities. The objectives of the conferences were to enhance and expand the teaching of remote sensing in universities. The 1978 conference was targeted at the 14 state western region and proceedings from the Conference are available.

A national Conference on Remote Sensing Education will be held for the first time on May 9-21, 1981 at Purdue University. This meeting will attempt to identify on a national basis the kind of skills and knowledge needed by those involved in remote sensing, share current experience in remote sensing education and explore ways for meeting the education challenge for the future. Proceedings from this conference should provide both a benchmark and the elements of a plan for the future.

Environmental Education — Beyond the 80's

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INTRODUCTION

When you are invited to discuss environmental education and where it is going in the future, your first reaction is O.K. that should be easy. Well, projecting the future is anything but simple; 10 or 12 years ago you and a small group could sit down in a small bar, have a few drinks, and pull out of the air the need for 49,000 wastewater treatment plant operators, 21,000 persons to work in collection systems, and another 20,000 or so in air pollution control specialties. All of these would have been reasonable since the federal government had the big bucks and numbers were needed to justify themselves to Congress.

Times have changed in many ways. The federal government does not have the big bucks anymore, the environmental problems are better defined now than they were then, although not completely defined yet, and probably never will be.

Programs Diminishing

Universities and colleges with their own environmental programs and the overall environmental movement that rose throughout the land has now dimmed and those who still are in the environmental education area, both professional and technical-vocational levels are there because they have, for the most part, been successful in education and training, and producing more for the environmental use that the community has been able to use.

There are some programs which still turn out graduates who, unless they follow it with a strong master program in a related technical field are having difficulties finding employment, but for the most part, the environmental programs still in existence are strong and doing quite well. The environmental community is

service oriented, and current and future jobs will continue to be service oriented. The reason why I state this is because when you look at the manufacturing area, very few, less than 10% of all persons involved and educated in the environmental areas are involved in producing a product which is environmentally oriented.

We will find, if we take a close look at the wastewater field that we have been on the big wave and have had a very successful surf toward the beach. The big money, billions of dollars, expended by the federal government in concrete and steel for the construction of municipal facilities is slowing down, the municipalities have built about all the concrete and steel that is possible, and at this point President Reagan has cut down the construction budget by half.

Future Indefinite

There are approximately 1,000 small facilities to be built over the next 10 years, but the total impact is only 1/10 of what was done in the past, so what is the future for wastewater environmental education and training field?

I cannot give you accurate numbers, and I believe there are some specific areas that will need greater emphasis than in the past. As we move through and become further and better defined in the environmental area we will again identify newer professions and newer technical levels.

The professional field will deal with areas mentioned this week during the national conference. Almost all of these specialties: the *super fund*, *solid hazardous waste*, *solid water*, *ground water*, and *water reuse specialties* are theoretical courses with their practical application in the field. On the junior colleges and community colleges level the same technical areas as mentioned before will be based on technical specialties of which the technical level programs will be the primary source. Again, these would have to be a very strong applied curriculum. For the most part, the technicians will be the hands and eyes of the engineers and scientists. In addition, the communities colleges and junior colleges will be able to continue to look forward to the wastewater plant operations courses, which most of you have been offered in your area as a continuing education course in the evenings.

Recent reports have indicated that between 50 and 70% of the wastewater plants constructed in the past 8 years are not meeting their permit requirements, nor the design capabilities. There are many factors involved, but one that has been measured is the concept of application for process control units. The student population already employed still has a need for continuing upgrading in the field of wastewater treatment.

Another area of continuing education which should reach its peak in the next couple of years will be municipal management. The wastewater treatment plants is one of the major consumers of energy that the municipalities have and it will find that optimum of facilities operations will prove to be its major energy savior.

In addition, there is one point that you all should remember, the wastewater treatment facility will be one of the last services that the city will have to provide. It might cut them all out, but this is one of the last that will be here.

Environmental Education and Training for Beyond the 1980's— Two Selected Needs

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INTRODUCTION

The request for this paper called for a determination of education and training requirements for beyond the 1980s. There is no doubt that there will be a strong and widespread need for an environmentally educated and trained national workforce (indeed, an environmentally educated public, as well) beyond the eighties. The specific requirements of this workforce are largely within our capability to determine now, and it is timely to begin the process at this time in order to prepare for the tasks that lie ahead.

This paper, however, deals with only two requirements: *The need to enlarge our national environmental interests to encompass a worldwide view of trends, needs, problems, and the distribution of resources, and the need to begin immediately to train those who will be the policy makers and administrators beyond the eighties.*

Need for a Worldwide View

On a worldwide scale, the needs and challenges for environmental management have never been as widespread, diverse, complex, and pressing as they are today. The factors contributing to these needs will be even more compelling beyond the eighties.

The most significant factor behind such needs is the global trend in population growth and concentration. The world population in 1975 was 4.09 billion. This represents a 55% increase, which, in absolute terms is equal to the size of the world's population in 1930.

Ninety percent of this growth will take place in the developing countries, representing an addition of about 2 billion individuals.

There will be a 48% increase in school-age children, and an 86% increase in working-age people (15-64 year olds).

In a world that today cannot provide adequate educational opportunities or sufficient employment (both in quantitative and qualitative terms), the implications for vast human hardship are ominous and certain.

Combine this population growth with the distribution of and demand for natural resources (including food, energy, nonfuel resources, water, forests, and fisheries), as documented in part by the *Global 2000 Report to the President of the U.S.* and the *World Conservation Strategy*, and the potential for social, political, and economic instability becomes obvious.

It is true that the population projections for the United States are encouraging. The 1975 population was about 214 million; the 2000 projection is 248 million, only a 16% increase, or 35 million new people.

We should not, however, be complacent. On the contrary, we should be concerned with worldwide trends for moral, environmental, and economic reasons. The human suffering elsewhere demands compassion. The environmental stresses call for assistance in planning and management to ensure optimum productivity and preservation of vital natural resources. The moral and environmental reasons for concern are clear. However, the economic basis for concern demands consideration.

Our lifestyle and consumption habits will likely increase our dependence on imported natural resources from other countries, particularly developing countries. (We, in turn, are likely to increase our exports of food, products, and technology to developing countries.) This web of economic interdependence is certain to become more intricate and prominent in the future. The environmental implications are twofold. First, as demand for natural resource exploitation rises, there will be a corresponding environmental impact. Second, should foreign supplies of certain resources be disrupted, there could be a relaxation of environmental standards at home in order to exploit domestic resources otherwise protected for environmental (and health) reasons.

Environmental planners would do well, therefore, to analyze national needs in the larger context of worldwide population, natural resource, and environmental trends and relationships. The first point of this paper is to call for enlarging our national environmental interests to encompass a worldwide view.

Need for Policy and Administrative Training Now

The second point of this paper is to call for an immediate process

YEAR	AGE	
	PERSON A	PERSON B
1950		
1960	10	
1970	20	
1980	30	
1990	40	10
2000	50	20
2010	60	30
2020	70	40
2030	80	50
2040	90	60
2050		70
2060		80
2070		90

AGE CALENDAR

This age calendar shows that people old enough to be in policy making and administrative positions immediately beyond the eighties are already out of school, while those people born in the eighties will be emerging from college shortly after the year 2000. Curriculum development efforts should, therefore, focus on needs beyond this century, while other types of educational efforts should be designed to train policy makers and administrators who are already in the work force.

to train those who will assume policy making and administrative positions beyond the eighties.

Consider the age calendar on the following page. The calendar shows that a person born in 1980 will be graduating from college shortly after the year 2000, by which time most of the projections appearing in the *Global 2000 Report* will have taken place. This means that school-based curriculum development efforts should focus on needs that lie beyond 2000.

We are now more concerned with getting there from here, in a safe and environmentally sound way. Environmental policy decisions (or the absence of policy) today will have profound effects on the success of economic development efforts and the quality of life over the next ten, twenty, and thirty years. We have just elected an administration of policy makers and administrators whose environmental posture will be with us for the next four to eight years. The age calendar shows that people who will occupy policy and administrative positions beyond the eighties are at least twenty-five years

old now. This group is, therefore, well out of school and in the work force now.

If we are to reach this group in order to build and strengthen their environmental skills and sensitivity, we must develop an approach designed to educate effectively people already holding jobs. This calls for using the media, including television, newspapers, and magazines as a general approach, and tailoring mid-career type training programs, short courses, and seminars to accommodate individuals interested in preparing for the difficult environmental choices that lie ahead between the eighties and the next millenium.

CONCLUSION

The world's population is growing and demands for natural resources are increasing. These trends have significant environmental implications that call for developing a world view of economic and environmental inter-relationships among nations and for beginning now, in the eighties, to groom the policy makers and administrators who will guide us into the next century, when our options will be far fewer than they are now.

Environmental concern in the past has been, in large measure, concern for the environmental and human health and well being of future generations. Indeed, our planning for beyond the eighties will also largely determine the quality of our own lives in retirement. Current environmental trends compel us to work fast.

Applied Ecology: The Transition Paradigm for the 1980's

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INTRODUCTION

A paradigm is a body of ideas sufficiently coherent to attract widespread acceptance (e.g., a disciplinary branch of science). Paradigms in science are needed to provide clearly the conceptual and contextual status upon which that branch of science depends. Paradigms define areas of science at particular times, as well as characterizing the approach to study for these often new fields of knowledge.

Both ecology and environmental science became recognized as important environmental paradigms during the 1970's. Ecology is defined as that scientific discipline which attempts to understand the structure, function and behavior of ecological systems, whereas environmental science is defined as an interdisciplinary science that attempts to measure and evaluate systems and the management of these systems for man's benefit and survival.^{1,11}

Surprisingly, these two paradigms, both of which relate to a better understanding of the natural world, are in reality at opposite ends of a philosophical (teaching and research) spectrum. An attempt will be made to illustrate this spectrum and then to suggest an approach whereby much of the current negative polarization between these important environmental paradigms can be utilized positively for training the environmental workforce needed in the 1990's.

An Environmental Spectrum

Table 1 summarizes several of the differences between ecology and environmental science. These differences need to be recognized and understood in order that positive steps can be taken in the 1980's to

train the personnel needed in such vital areas as technological impact assessment, systems analysis, resource management and land-use planning.

Ecologists have long recognized the ecosystem as a basic unit of study in ecology.⁸ Johnson summarized current ecological concepts as they relate to an ecological (ecosystem) paradigm.¹¹ In the past, much information was collected concerning ecosystem structure (e.g., population density, standing crop biomass or species diversity) with only limited information gathered regarding ecosystem function (e.g., resource cycling, ecological energetics or ecosystem development). In recent years, however, information has been collected and evaluated in an attempt to understand better total ecosystem dynamics.⁹

Ecosystems have traditionally been viewed as *natural* systems (i.e., the impact of man on ecosystem structure and function has been largely ignored). Although man is defined as "man in nature" by most ecologists, ecosystem studies usually focus on a "man outside nature" approach. Man-related compounds (e.g., pesticides, heavy metals or radioactive materials), however, are now found in most "natural" ecosystems. Further, the influence of man's socio-economic system on ecosystem dynamics can no longer be ignored.⁹

Table 1. A Summary of Differences Between Ecology and Environmental Science⁴

Attribute	Ecology	Environmental Science
Unit of Study	Ecosystem	Noosystem
Research Algorithms	Scientific Method	Problem Solving
Academic Philosophy	Disciplinary	Interdisciplinary
Research Philosophy	Basic	Applied
Graduate Degree		
Philosophy	Liberal Arts	Professional
Anthropomorphic		
Connotation	Man "Outside" Nature	Man "In" Nature

For these and other reasons, Barrett proposed that the *noosystem* might best be defined as the basic unit of study for environmental science.⁴ The *noosystem* concept would include not only the study of the structure and function of nature, but also would include the social, economic and cultural influences on ecological systems as well (i.e., the *noosystem* concept would attempt to include biological, physical and social science influences and interrelationships).

Ecology presently carries with it a strong connotation for the biological sciences, is based on a liberal arts, scientific-method research

methodology and is disciplinary in its teaching and research philosophy.^{2, 12, 13, 14} Environmental science relates to environmental principles and processes regardless of discipline, is based on an applied, problem-solving methodology and is interdisciplinary in its teaching and research philosophy.^{11, 12, 17} Thus, there exists an environmental spectrum ranging from the liberal arts (ecology), basic research approach to the natural world (i.e., the study of ecosystems) to the professional (environmental science), applied research approach to the natural and man-made environment (i.e., the study of ecosystems). It is imperative that this gradient be recognized and personnel be trained to function along the gradient as a whole. We no longer have the time or financial resources to remain polarized at each end of the spectrum.

Undergraduate Education

Students at the undergraduate level need to become trained in a three-pronged manner. First, they need to become educated concerning those algorithms that help one to explore the environment in a truly interdisciplinary manner (e.g., scientific method, problem solving, ecosystem analysis, net energy, modeling and cybernetics). It is important that students learn how to attack systematically a problem and to recognize that different algorithms may be employed as different circumstances and factors dictate. Individuals educated in research methodologies of both ecology and environmental science will be in the greatest demand in the future.¹⁸ Further, Shull pointed out that each student should possess a set of tools that enables that person to define, attack and solve new problems.¹⁸

Second, each student should continue to select a disciplinary, liberal arts major based on his or her field of interest, background and aptitude. It is hoped, however, that students will enter the environmental arena from a diversity of disciplinary fields, i.e., from a mixture of biological, physical and social sciences. There are also excellent opportunities for students to enter the environmental profession from the humanities and fine arts as well.

Third, undergraduates need to select a second major or minor from an environmental problem area. Numerous colleges and universities have established applied (mission-oriented) areas of study (e.g., energy, environmental toxicology, water resources, environmental education, recreational administration and public information). A double major would be a student with a major in a traditional discipline (e.g., botany) and a second major in a problem-area field of study (e.g., park management). A diagram and summary of this undergraduate academic philosophy has recently been reported.²

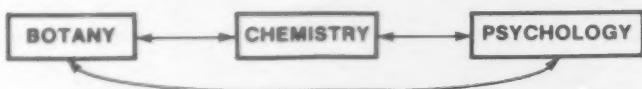
Students with this academic background would be better justified to (a) enter the research technician job market because of their broad (problem-solving) background, complemented with their double

major, (b) enter traditional graduate programs in their liberal arts (disciplinary) field of study, or (c) enter graduate programs in new, professional (interdisciplinary) fields of study.

Graduate Education

Present ecology graduate programs can be grouped into four (4) major categories (Figure 1). Pluridisciplinary (cooperation without coordination) represents those programs in which ecological principles, concepts and research opportunities are gleaned from a diversity of departmental courses. Each graduate student has a departmental home base (e.g., botany) in which he or she receives the graduate degree. During the 1970's, this was the most common mode for training graduate students with an interest in ecology.

A. PLURIDISCIPLINARY (Cooperation without coordination)



B. CROSSDISCIPLINARY (Polarization toward disciplinary concepts within other disciplines)



C. DISCIPLINARY (Specialization in isolation)



D. INTERDISCIPLINARY (Coordination by higher level concept)

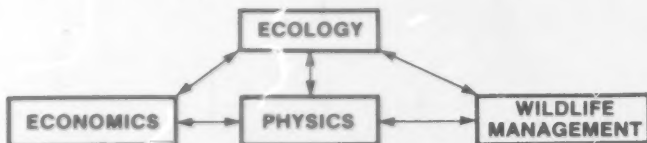


Figure 1

Crossdisciplinary (polarization toward disciplinary concepts within other disciplines) represents those programs centered around ecology teaching and/or research institutes. This category often represents a polarization toward a specific concept or research approach (e.g., systems ecology or ecosystem energetics). Students normally receive their graduate degree(s) in a traditional department but utilize the institute for special integrative courses and/or research opportunities. The institute serves as an important interface with participating departments.

Disciplinary (specialization in isolation) represents those graduate programs in which ecology is administered as a new, holistic discipline.¹¹

These programs tend to attract a nucleus of ecologists within a given institution and, therefore, leave the traditional departments (e.g., zoology) without a strong ecological teaching or research component. The advantage is that personnel from a wide array of academic backgrounds can interact in an integrative manner regarding ecological teaching or research functions.

Interdisciplinary (coordination by higher level concept) represents those graduate programs in which ecological processes (e.g., cybernetics or problem solving) are used to coordinate a diversity of personnel (both faculty and graduate students) concerning ecological teaching or research endeavors. This category represents the newest of the ecology programs to emerge in the 1970's.

It should be pointed out that these same four categories (A-D) could also have been outlined for environmental science programs. For example, environmental science concepts and principles are frequently team taught by personnel from existing departments, although the graduate student obtains his or her advanced degree from a participating department (Model A). New environmental science research institutes have become established to help coordinate research projects around a centralized theme (Model B). A number of new environmental science programs (baccalaureate through doctorate) have arisen during the past decade (Model C). Finally, a few environmental science programs have been developed to coordinate teaching and research functions around a higher level concept (Model D).

Thus, the 1970's proved to be a decade when both ecologists and environmental scientists anchored academic programs in an attempt to train the personnel needed to help solve major environmental problems in the years ahead. The evolution, structure and administration of these programs (models) often depended on the resources (e.g., financial, human and natural) available at the time of conception. Most would be considered successful when compared with the

diversity of graduate programs and research opportunities which existed in the 1950's and 1960's.

Evolving in a subtle manner, however, is the polarization previously described between ecology and environmental science. I suspect the recent pressure to establish a National Technological Foundation (NTF) as an applied counterpart to the National Science Foundation (NSF) has its roots in this academic and research philosophy.¹⁰

Applied Ecology

For the next decade, this nation will have great needs for scientists and engineers.¹ These needs will become particularly acute as they relate to personnel trained to view and help solve environmental problems in a holistic approach. Personnel trained in such fields as ecological toxicology, computer science, chemical engineering, energy resource management, integrated pest control, stress ecology and impact assessment will be in high demand in the 1980's and 1990's.

Since applied ecology is an important component of environmental science and since applied ecology represents the largest section within the Ecological Society of America (Figure 2), I suggest that applied ecology be recognized as that transition science which encompasses the principles, concepts and algorithms of both ecology and environmental science in an attempt to train personnel across the total environmental spectrum (Table 2).¹²

More attention should be devoted to the process by which problems are solved. New, interdisciplinary "process" courses (e.g., ecological cybernetics, net energy and problem-solving methodologies) would integrate and coordinate this type of environmental curriculum. Thus, applied ecology programs could and should become established in colleges and universities which provide a new, holistic curriculum. Such programs should be very cost effective as institutions of higher learning face increased financial burdens in the 1980's (e.g., inflation, declining enrollments and capital improvements). New fields of study which emerged during the 1970's include ecosystem analysis, resource science, systems theory and

Table 2. The Applied Ecology Niche Between Ecology and Environmental Science.

ECOLOGY (DISCIPLINARY)	APPLIED ECOLOGY (TRANSDISCIPLINARY)	ENVIRONMENTAL SCIENCE (INTERDISCIPLINARY)
BASIC	INTEGRATIVE "ENVIRONMENTAL SPECTRUM"	APPLIED

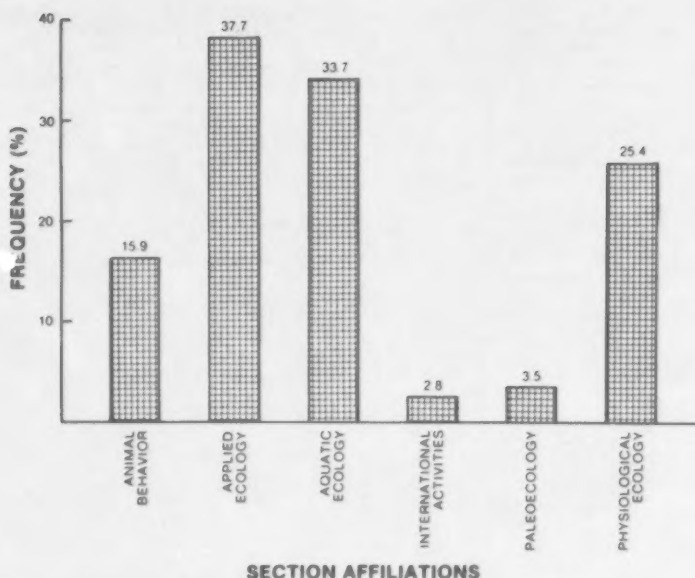


Figure 2

stress ecology.^{6, 7, 9, 10} These, and others as previously mentioned, could become vital areas of teaching and research within the applied ecology paradigm.

Applied ecology programs could also serve as an industrial-academic-governmental interface in the years ahead. Internship, practicum and co-op programs should continue to flourish as applied ecology centers of excellence develop. Graduate students would receive "real-world" experience and senior scientists would become "re-tooled" as new research technologies and algorithms evolve. Such centers could focus on long-term ecological research problems (e.g., acid rain or net primary productivity). Integrative applied ecology programs would, therefore, provide the environmental manpower needs during the 1980's and beyond.

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